Electrical Review

Vol. 78—No. 19. CHICAGO, SATURDAY, MAY 7, 1921. Page 723.

Electrification of Steam Roads an Economic Necessity

Motor Drive Removes Restrictions Imposed by Limitations of Steam Locomotive Characteristics—Fuel and Labor Saved by Change to New Motive Power — Track Capacity Increased

By A. H. ARMSTRONG

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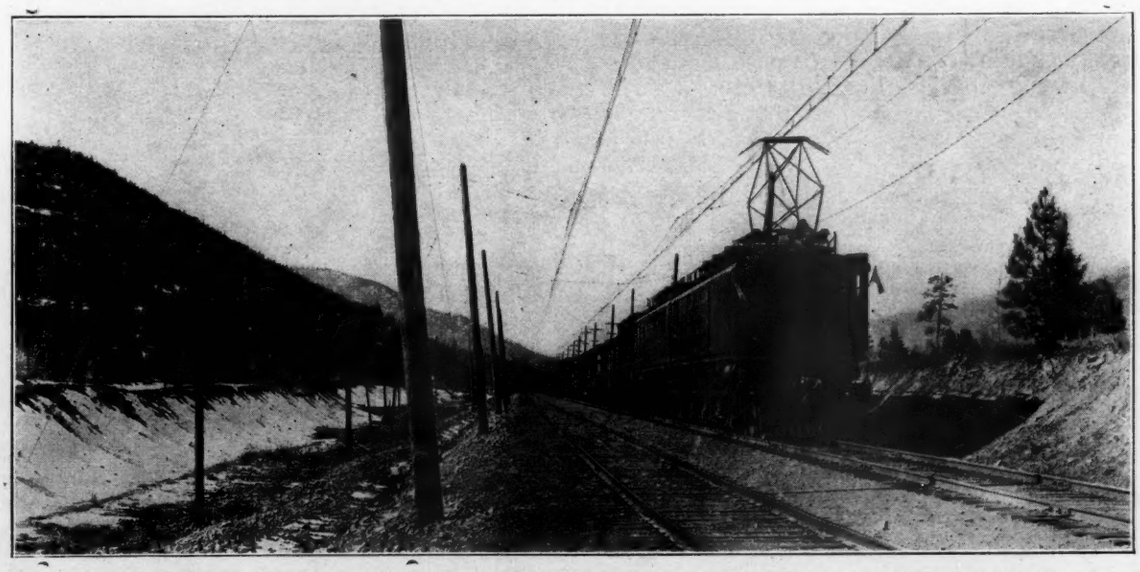
An industry valued at something like $19,000,000,000 cannot be ruthlessly tampered with and escape serious economic disturbance, especially when it is closely interwoven with our national prosperity. The story of our railway development is part of the written history of the country. It is, therefore, a matter of grave national concern to properly diagnose the true nature of the ailment affecting our transportation system and prescribe the treatment of greatest promise for its future recovery.

To the great main lines binding East and West, North and South, have been added branches reaching into new country and bringing more products to swell the ever growing traffic of the parent stem or main line. Engines of greater power have tried to cope with the demands of an increasing traffic and have been assisted by such improvements as heavier rails, automatic air brake, grade revisions, block signals and better terminal facilities. Finally, however, when congestion on some main lines became too great with steam-engine operation it was necessary to add a second or even third or fourth pair of rails to care for the traffic.

The limitations of the steam engine are not so keenly felt upon branch or feeder lines with the infrequent small-tonnage trains incident to this service. The congestion on main lines has in many cases, however, become most acute, and it is under such conditions that the steam engine plainly imposes its limitations upon the physical and economic showing of a railway property. Appreciating the need of building new lines into new country to some limited extent, the big problem before us is to greatly improve the railway machine we have already created. We want cheaper and quicker transportation over existing tracks, more reliable service, less congestion at terminals and proper provision for the future growth of traffic that in the past has doubled every 12 yrs. This is a large order to place upon steam-engine operation, now constituting the foundation upon which our present railway system rests and which many competent critics think is one of the fundamental causes of its



This 5000-Ton, 100-Car Freight Train Is Employed on the Missoula Division, C., M. & St. P. Ry.

economic collapse and the consequent handicap to all branches of industry.

We have practically built up our national life around the possibilities and limitations of the steam engine, taking advantage of such improvements from time to time as the advance in its development permitted. But at all times the steam engine has been the determining factor in establishing the entire railway development and has fixed present standards of train loads, speeds, delays, division points, labor conditions, wages, location of road and the multitude of factors entering into the vast railway problem. And this big machine has arrived at the point where it costs so much to keep it running that even greatly increased rates will not pay the bill and leave enough over to pay a fair return upon the capital invested. In this respect a fair return is placed by our government at the modest figure of 6% of present valuation.

If we are to continue to exchange our eastern manufactured for western raw products the carrying charges over the intervening miles must be kept at a minimum. In no other country in the world does one man's labor produce so much, and specialized communities cannot continue to exist as such without the cheapest kind of transportation to facilitate the movement of surplus product from one end of the country to the other. The answer to the present "sleeping sickness" attacking the prosperity of both railways and industries cannot be found in the merry race of higher transportation rates climbing after increasing labor and fuel costs.

We are facing the facts of an 8-hr. basic working day with time and one-half for overtime, greatly increased wages, fuel prices at levels never before reached, and maintenance costs that are practically prohibitive. We are told that vast sums of money must be expended on construction and new equipment to make good the deficiencies of the war period and provide for future growth in traffic. But no assurance is offered that such material additions to capital account will result in reduced transportation rates, better service and a higher economic return upon a property already equal in value to our entire national war debt. In fact, it is apparently not possible to make such fundamental changes in railway operation and economics as are evidently necessary to accomplish the desired results simply by investing still greater sums in the old steam-engine facilities that have in the opinion of many failed to advance with the needs of the times.

No Great Improvement in Steam Operation Appears Evident.

Such minor improvements in steam-engine design as are already available or in view do not hold promise of any real relief from present operating conditions. The steam engine seems destined to spend the greater part of the year tied to the coal bunker, water tank, round house, ash pit, and repair shop with too little time left for the actual haulage of trains. It is wasteful in man power, especially on heavy-grade divisions, and in these days of high wages and short working hours with severe penalty for delays leading to overtime this low efficiency in utilizing engine and train crews is fatal to economic success. It is a notorious waster of fuel, burning a quarter of all the coal mined, and finally its cost of upkeep and depreciation are so high as to constitute a most serious percentage of the total operating expense.

Perhaps this may seem a rather sweeping criticism of the steam engine. On the contrary, such facts are well known, but perhaps not fully appreciated unless compared with the operating records of other types of motive power. The steam engine has held supreme in the railway field for so many generations that to some it seems heresy to question its exclusive right to dominate it for all time.

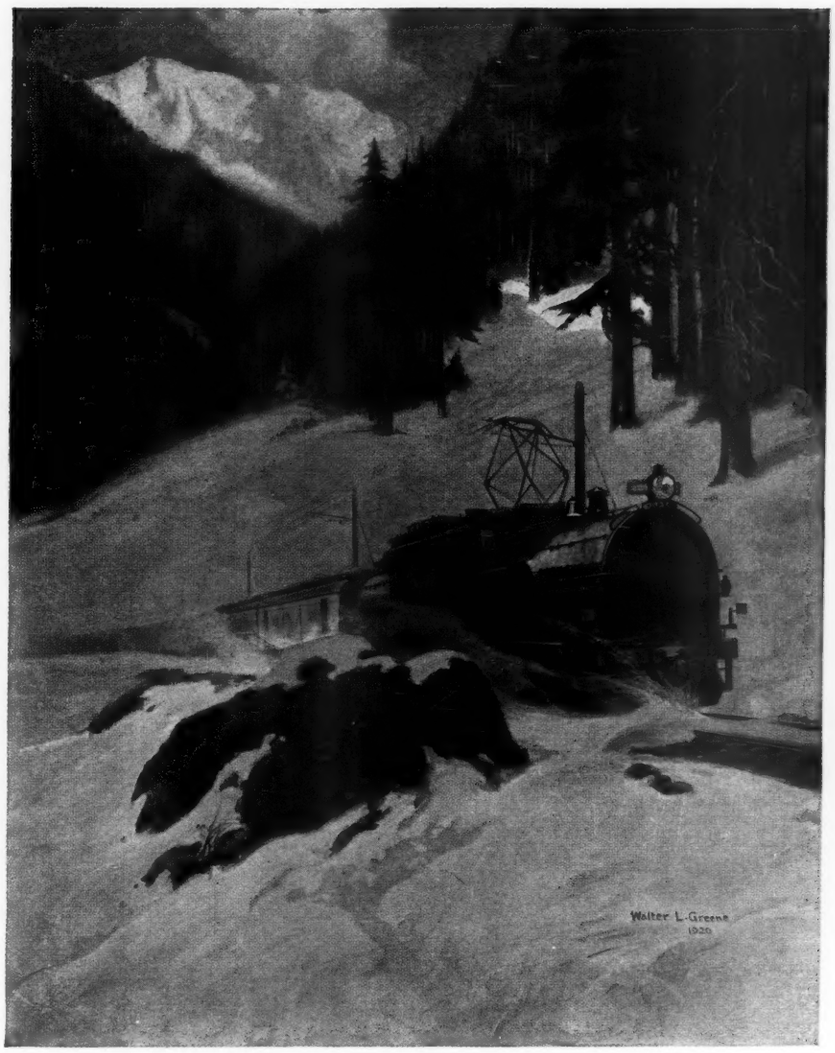
Competition in Field of Steam Railroad Transportation.

During the past 20 yrs. serious competition has entered the field of steam railway transportation. Electric railways have taken over the short-haul passenger traffic, and in addition have created travel that never was enjoyed by steam roads. The motor truck has captured a great part of the short-haul express movement at the expense of both the steam and electric railways. To be sure, this motor-truck traffic is partly a left-over from war conditions which demanded quick deliveries regardless of cost, while it has thus far borne no reasonable portion of public road upkeep. Nevertheless, railways must reckon with short-haul motor-truck competition in the future to an extent not as yet clearly defined.

The driver of any automobile will declare that he dodges more tonnage carried on motor trucks over main public roads than is in evidence on the railways they parallel. When comparatively small trucks bumping over public highways, not too well maintained at the taxpayer's expense, can successfully compete with rail transportation something has evidently happened during the past few years which calls for a readjustment of our previous ideas of transportation. It takes a pull of approximately 50 lbs. to move a ton over the varying grades and surfaces of our highways, while the same 50-lb. pull will haul 10 tons of load over steel rails. Moreover, trucking power is obtained from one of our most expensive fuels, and gasoline substitutes are already being eagerly sought after to supplement a product that is fast becoming inadequate to meet the growing demands.

American Practice Built Up Around the Long Heavy Train.

The late J. J. Hill built up the Great Northern property by an early recognition of the fact that while receipts are proportional to ton miles operating expenses are determined by train miles. While efforts to increase train loads were most successful in building up that great property serving the needs of a new and sparsely settled country, does not the growing competition of the motor truck cast serious doubt upon the wisdom of too close adherence to the same inflexible principle when applied to the conditions obtaining in the congested districts of the East? Admitting the lower expense of train crews with the heavier train loading, is it not possible that the delays inseparable to slow-drag feights have materially contributed to establishing the motor-truck indus-



" . . . who shall place
A limit to the giant's unchained strength
Or curb his swiftness in the forward race?"

—BRYANT

Reproduction of a painting by Walter L. Greene of Schenectady, N. Y., showing a General Electric passenger locomotive operating over the Cascade Mountains on the Chicago, Milwaukee & St. Paul Railroad.

Courtesy of General Electric Company

try that offers quick delivery as its one chief asset? In his efforts to reduce ever increasing operating costs, has the railway operator been too busily concerned in running his huge transportation machine to fully observe the industrial needs of the country and appreciate the evident value placed by the shipper upon speed?

We must admit that the American visiting Europe for the first time is quite likely to look upon its railways as somewhat of a joke. The small cars, light engines and low-tonnage trains contrast unfavorably with American practice as to size. Afterward, however, the interesting discovery is made that most excellent service is given to a densely populated country by these small frequent trains and that American methods would possibly not suit such conditions at all.

It is a wide jump from the motor truck on our public roads to European railways. Can we not learn the same lesson from each—and that is, that our present railways do not properly serve the more congested districts through which they pass and that our railway directors have themselves to blame if they do not profit from a recognition of the fundamental facts underlying the growing menace of motor-truck competition? Quite evidently our railways as now operated do not provide the service our eastern shippers want.

Shall the short-haul freight traffic be surrendered to the motor truck as was the short haul passenger business to the electric railway, thus leaving our steel highways free for heavy through train movement only? Can such through traffic alone pay for the upkeep of the property? If not, what steps can be taken to compete for the short-haul business? These are most pertinent questions in view of the fact that many more millions are being spent in building macadam roads and motor trucks than are apparently available for railway betterment.

Effectiveness of Electric Traction Amply Demonstrated.

Electricity has amply proven its effectiveness in the operation of light high-speed trains in congested zones. Steam traditions of a busy track have been shattered by electric train performance. With such successful examples before us as our elevated roads, subways and electrified railway terminals, there can be no dissenting voice raised to challenge the statement that the adoption of the electric motor introduces the means of making radical changes in steam-engine practice in congested terminals. Not only is the electric motor pre-eminently fitted to meet the needs of short-haul, frequent-stop service, but it gives opportunity to relocate and redesign the whole terminal railway property along lines impossible to the steam engine.

Contrast the Grand Central terminal of today with that of 1906 before electricity had replaced steam. The air rights over the yards have become most valuable, huge buildings have been erected, adjacent property greatly increased in value and, in fact, a new residential, hotel and office center has been created in what may now be called the center of New York City. The Pennsylvania terminal eliminates the handicap of the Hudson, and the whole picture is rounded out by the growing subway facilities. In fact, New York City is being electrified, that is, as regards its passenger transportation, and a similar transformation is about to be commenced in Chicago with the substitution of electricity for steam on the Illinois Central.

But that is not all. The way has been shown to solve the equally vital problem of handling freight and express matter in city terminals. The very nature of a steam engine has banished the railway terminal to the outskirts of a city, or has it been that our cities have developed as far away as possible from an undesirable neighbor? In any case the steam terminal is not immediately adjacent to the shipper or center of distribution, nor is it well adapted to the expeditious and economic handling of freight. Electric terminals, on the contrary, may be located with proper regard to the needs of the shipper in the very center of our biggest cities if necessary. Tracks may enter terminal warehouses on two, three or more levels and use but a fraction of the real estate required for an open steam terminal yard. In other words, there are apparently just as great opportunities to effect a transformation in our freight terminal facilities as have already been partly completed in passenger stations and approaches. Furthermore, the solution of the freight terminal problem will go far towards settling the question of short-haul competition, and electricity opens the way to overcome the handicaps of the steam engine which is now blocking the further development of the transportation machine.

Steam Locomotives Use and Waste Great Quantity of Fuel.

Approximately one quarter of all the coal mined in the United States is consumed by our railways, and a great part of this fuel estimated at possibly one-third of the total is wasted in so-called standby losses in the 63,000 engines utilized in hauling our trains. The modern engine is equipped with all possible improvements designed to increase its fuel efficiency, but nevertheless its main purpose to which everything else must be largely sacrificed is to render reasonably reliable service in hauling trains under all conditions of weight, speed, grade and climatic changes. The fuel economies which it is possible to introduce in a moving structure cannot compare in effectiveness with the developments incorporated in modern electric power stations. The restrictions of track gage, wheel base, axle weights, and running qualities of the steam engine must impair the effectiveness of its boiler plant. Furthermore, each steam engine is a complete individual power plant subject to all the variations in load incident to hauling trains over a broken profile with intermediate and terminal delays. The boiler must be kept hot at all times regardless of whether the engine is doing work or not, thus giving rise to the standby losses that form so great a proportion of the total fuel consumed.

The electric locomotive, on the other hand, comprises in the electric motor the most efficient and flexible known means of transforming potential into mechanical power. The variations in load of each individual locomotive in operation are largely smoothed out when superimposed upon the average demands of possibly 50 or more other locomotives, with a resulting load curve at

the power house supplying them all that is sufficiently uniform to insure the most efficient use of fuel. The steam turbine and auxiliary station apparatus have been developed to such a high state of efficiency that manufacturers' guarantees can be secured of 8 lbs. of water per electrical hp-hr. Large power houses are in operation at the rate of 14,000 B.t.u., or approximately 1 lb. of high grade coal per electrical hp-hr. output.

Based upon the performance of 60 huge electric locomotives operating over nearly 700 mi. of route on the Chicago, Milwaukee & St. Paul Railway, and on other facts of record, it has been estimated that the passenger and revenue-freight tonnage of the United States could be hauled by electric locomotives for one-third the coal now burned under steam-engine boilers. Not even the most ardent electrical enthusiast advocates the immediate electrification of all our steam railways, but the above comparison is offered as a measure of the magnitude of the present wastefulness of burning fuel and the ultimate goal toward which the electrification movement is directed. In this connection it is of interest to note that railway fuel carried in cars and steam-engine tenders equals approximately 20% of the total revenue-freight tonnage carried over our rails, and practically all of this nonpaying tonnage could be saved by electrification. The adoption of electricity therefore would immediately increase the carrying capacity of our railways a fifth by eliminating the railway-coal-carrying business from the rails.

While our country boasts of its almost unlimited fuel reserves and is wasteful to a degree, such is not the condition in other parts of the world. England, France, Belgium, Switzerland, Sweden, Italy and even bankrupt Austria, all have entered upon an immediate program having for its final objective the universal electrification of the public and privately owned railways in those countries. Shortage of fuel is the most pressing incentive, and available water powers will be utilized to the utmost. A constructive government policy makes such an enormous undertaking possible and is in marked contrast to the politics that have brought our own railways to such a sorry financial plight.

In many instances congestion on mountain-grade divisions has reached such a point that additional rails must be laid to obtain the needed relief with continued steam operation. It is in just such service that the electric locomotive offers very great advantages. Drawing power from a practically unlimited source of supply, and free from the structural restrictions of the steam engine, the electric locomotive may be built to deliver any tractive power at any speed required by the operating needs of the service. Steam engines are now in operation that will give a maximum draw-bar pull up to the limit of standard draft rigging, but the speed of such powerful Mallet engines is so low as to greatly restrict the rapid movement of freight over heavy mountain grades. Not only can electric locomotives develop equal pull, but sustain full tractive power at double the speed possible with the heaviest steam engine.

Thus, while one St. Paul electric locomotive hauls a 3000-ton train up a 1% grade unaided at a speed of 15 mi. per hr. it is quite probable that we may anticipate the early demand for still greater power. Indeed, draft gear on commodity freight cars at no distant date may be so improved as to permit hauling a 5000-ton train up a 1% grade. This would demand a tractive effort of 135,000 lbs. at the drivers and an output of the electric locomotive of 5400 hp. at a speed of 15 mi. per hr. Higher speeds at the same tractive effort are entirely feasible; in fact, the manufacturers of electric locomotives would today contract to build such an enormous machine and guarantee its output with no hesitancy as to their ability to "make good."

Electric Locomotive Development Removes Many Restrictions.

Full appreciation of this fact of the availability in one locomotive structure of power far in excess of anything possible with the steam engine opens up unlimited opportunities for readjustment of present methods of operating our steam roads. In other words, instead of steam-engine railroading as in the past we are offered the opportunity to enter into an era of real unrestricted railroading with the motive-power "lid" removed.

Development of the more powerful electric locomotive is a determining factor in the matter of grade revision, double tracking and mountain-division operation. Not only does the operation of the electric locomotive greatly increase the tonnage carrying capacity of present tracks and postpone for an indefinite period the day of laying additional rails under most difficult and expensive conditions, but it also greatly reduces the hazards of heavy-grade railroading by utilizing the so-called "regenerative braking" feature on down-grade movement. It is an impressive sight to witness a 3000-ton train being hauled up the 1.66% grade, over the divide at Donald and dropped down 2000 ft. at Piedmont on the 21 mi. of 2% descending grade of the Chicago, Milwaukee & St. Paul without once using the air brakes. The mechanical power developed by the descending train is regenerated and returned as electricity to the trolley to be used by some other train, instead of being wasted in the heating brake shoes and wheels inevitable to the use of air brakes. Besides eliminating much of the risks of grade movement, electric braking contributes to the relief of traffic congestion as it permits using higher speeds on the down grades with safety.

One of the marked advantages promptly discovered in the electric locomotive is its great reliability and consequent low cost of maintenance. For a period of 10 yrs., or until the high cost of living struck the electric locomotive as well, the 120-ton New York Central electric locomotives were maintained for approximately $0.035 per mile run—a noteworthy achievement when compared with the upkeep of steam engines of equal power. Even during the year 1919 the St. Paul electric locomotives weighing nearly 300 tons and making some 60,000 mi. a year were maintained for approximately $0.15 per mile run, or less than one-third the upkeep of Mallet engines of equal tractive power.

And so this discourse could continue to present facts showing the especial fitness of the electric

motor for the varied needs of rail transportation. While our railways are used for the wholesale movement of passengers and freight they are, nevertheless, engaged in the retail burning of fuel under 63,000 individual boilers with the waste inseparable from such a necessity. The adoption of electricity assures such a vast fuel saving that even the most careful estimates appear startling to those who have not studied the facts available.

Electrification of mountain divisions has demonstrated a large increase in single-track capacity, estimated by some to be at least 50% greater than possible with steam-engine operation. In many instances this improvement can be secured at a less expenditure than would be required for double tracking and also show a greater return upon the new capital charge incurred.

Cold weather does not affect the electric locomotive at all—in striking contrast to the frozen steam engines of the winter 1917-18—while its greater safety and reliability on grades are matters of record. Electrified terminals and approaches to large cities should revolutionize present steam-engine practice and not only effect economies in operation, but greatly stimulate traffic by introducing radical improvements in facilities. In other words, terminal electrification offers attractive opportunities to both the holder of railway securities and the shipper.

Conditions demand that the efficiency of labor must be increased, and electric operation has demonstrated its effectiveness in this direction both on the road and in the shop together with complete elimination of coal and water facilities, ash pits, turntables, round houses, etc. In addition, locomotive division points may be indefinitely extended, and already runs of 440 mi. are being made with a single electric locomotive.

All these improvements in the electrified railway property will cost large sums of money. In some items of operating expense, such as fuel, crews and maintenance, direct savings are affected of such magnitude as to show a reasonable return upon new capital charges incurred in electrification. The argument for electrification, however, is built upon a broader foundation than a direct return upon the investment involved. In fact, it has to do with the vital question of the future growth of our transportation system and its effect upon our national prosperity. We have come to a period in our railway development where many regard the steam engine as inherently responsible for much of the physical and economic troubles now most painfully apparent. If we may correctly interpret the needs of our railways they require a major operation rather than the application of a bit of plaster. The steam engine may well retire with full honors from a field which has outgrown it and give way to its younger rival. Youth must be served.

NEW FACTORY FOR CONSTRUCTION OF ELECTRIC TRUCKS.

Vehicles made in the plant of the Commercial Truck Co., Philadelphia, are to be found in service all over the country. After 15 years of successful production this company has again outgrown its quarters and recently moved into a new factory building. The plant is of the most modern type single-story saw-tooth construction. Its capacity is nearly four times that of the old factory, and by employing three shifts this, of course, can be still more increased. Yet large as the plant is, provision has been made for two new sections each as large as the present building. Since the water system, sewers, heating lines and electric wiring are already provided, these additions can be erected within three months time when needed. The machine shop, assembly floor, wood working plant, and paint shop are equipped throughout with the most up-to-date electrically operated machinery. Motor-driven blowers and electrically heated furnaces are part of the forge shop and foundry equipment. There is a large steam plant for heating purposes, but all the power requirements are supplied from the lines of the Philadelphia Electric Co.

Through all the years that the Commercial Truck Co. has been building vehicles the first truck turned out by the factory has been giving economical and reliable service for its owners. This "old timer" is a 5-ton machine which was put in service by the Pennsylvania railroad in 1907. It has the 4-wheel drive, the motors being geared direct to each wheel. This direct gearing of the motors to the wheels is an exclusive feature of the C-T trucks.

OUTLOOK IN THE COPPER INDUSTRY SHOWS GREAT PROMISE.

Developments in Electrical Field Require Vast Supply of Metal for Manufacture of Equipment and Building of Lines.

The earliest adaptation of copper to the needs of man is shrouded in antiquity. The metal is believed to have served the human race both for purposes of ornamentation and for the manufacture of tools, weapons and other utilitarian devices before the first glimmerings of historical knowledge illuminate the past. The ancient Egyptians used copper long before the establishment of the "First Dynasty." They are thought to have employed native copper in their crude arts as early as 7000 to 9000 B. C., while the process of alloying tin with the metal to produce the harder substance, bronze, undoubtedly antedates the building of the pyramids, according to information given out in the *O-B Bulletin* of the Ohio Brass Co., Mansfield, O.

Copper has, through all the ages, played a very important role in the development of civilization. With the rapidly increasing use of electricity the metal now bids fair to fill a still more essential place in our economic life. It is the best suited of all metals for use in electrical equipment owing to the fact that it is the only known metal of high conductivity which can be produced in large quantities at a relatively low cost.

The copper mining and refining industry of the United States is of comparatively recent origin, dating back only to 1844, when a few tons of black copper ore were taken from a fissure vein in Keweenaw county, Michigan. Prior to that time, the world's infant copper trade had been chiefly supplied by the output of the Welsh mines and the ancient Rio Tinto mine in Spain.

The New World was now destined to supplant Europe in the production of commercial copper.

After the location of the now world famous mines of the Lake Superior district there followed the discovery of the fabulously rich deposits of Arizona, Montana, New Mexico and Utah. As a result of the working of these fields and mines in other districts of lesser importance the volume of American copper production in proportion to that of the remainder of the earth has steadily risen until at the present time it is estimated that the United States supplies nearly 60% of the world's total production.

The industry has in recent years been greatly stimulated by the general increase in electrical installation in all countries.

The difficulty of obtaining adequate supplies of coal and petroleum for manufacturing and industrial plants, at a reasonable cost, taken together with the prospect that the natural resources of these fuels may be soon exhausted, has led to the building and projection of many hydroelectric power stations. This development has, of course, created a large demand for copper wire and appliances. The proposition of creating power zones as a means of conserving coal has also been seriously considered in many quarters. Under this plan fuel would be burned at a central station, preferably at or near the mines; the power produced would be converted into electrical energy and transmitted over radii of wires to the consuming plants within a fixed zone. Such constructions would also call for great quantities of the red metal.

Copper was a commodity in a strong demand position before the war lifted its market to record price levels. That the metal is an essential factor in the prosecution of modern warfare became apparent shortly after the declaration of hostilities. Germany was the first of the belligerents to feel an acute copper shortage and the desperate measures taken by that nation to secure sufficient supplies are matters of historical record which need no repetition here.

Present Depression in Copper Market Only Temporary.

The rapidity with which the fundamental conditions necessary to the continued progress of the copper industry will be restored is a matter of conjecture. It should be borne in mind that the mining and refining of the red metal is one of our great basic industries, second only, in its field, to the production of iron and steel. The markets for the latter are also, at the present time, passing through a period of depression and liquidation, but no one for a moment doubts that this state of stagnation will give place to healthy and active demand just as soon as the readjustment of world finances and production to a normal basis can be accomplished.

The large stocks of accumulated refined copper which have been embarrassing the industry since the signing of the armistice have been materially reduced. Since the first of January, 1920, this reduction is estimated by copper trade statisticians to have approximated 75,000,000 lbs. It would seem that with a few months of fair business and somewhat curtailed production (as at present obtains) the surplus stocks can readily be reduced to pre-war levels.

Copper-bearing ore in most localities usually contains other metals in commercial quantities. The recovery of silver from ores treated primarily for their copper content often yields a substantial revenue, while considerable returns are frequently derived from the by-product of zinc, lead and even gold. The depression in the market for silver and the baser metals existing contemporaneously with that of copper has therefore further reduced the operating income of many companies.

Electrical Industry Requires More Copper.

That there is a great deferred demand for copper and copper products both in this country and abroad is the conviction of most of those who have studied the market. We are told that of the entire quantity of copper produced in this country during the war period more than 90% was utilized for war purposes. The normal requirements of lighting and power plants, traction systems and other developments employing electrolytic copper in large quantities were therefore unsatisfied.

Many of our traction companies and public service corporations in this country have suffered impairment of their purchasing power through the diminishing value of the fixed charges which they have been permitted to collect. The condition of a relatively stationary revenue account to offset a soaring maintenance expense has been the problem of most service organizations of a public or quasipublic character. As a result most traction, power and light companies have cut expenditures for new equipment "to the bone." These concerns will certainly be buyers of copper wire and other products in big volume just as soon as the restoration of their financial equilibrium makes such expenditures practicable.

The resumption of deferred construction work of all kinds will call for immense quantities of copper of both electrolytic and lower grades. The great future of copper is, however, indissolubly linked with that of electrical development, and having in mind the essential part played by copper in practically all applications of electricity to the needs of man, one who believes in the future of electricity must likewise believe in the future of copper. The development of the world's copper business in all its diversifications is bound to go steadily forward and the current price situation, while exerting a passing depression upon the industry, cannot seriously check its development.

The essential character of the industry, the growing importance of electrolytic copper in its relation to our every-day life and the increasing manufactures of copper, brass and bronze argue that the prices for the metal are now nearing their lowest level for a long period in the future. There is a slight probability that the next few decades will witness any general over-production of copper. The excess supply which has embarrassed producers during the past two years was occasioned only by the terrific stimulus of a world war, and its slow depletion is due only to the temporary stringency of finances affecting would-be users.

The recurrence of such a situation within the lives of the present generation is highly improbable. There is, on the other hand, ample cause for thinking that the demand for copper, especially in the form of new electrical equipment, will rapidly expand with the onward march of civilization.

Electric Motor Installed After Mill-Engine Failure

Record Time Made in Construction Work Required to Tear Out Old Equipment and Erect Electric Drive — Good Output Secured on First Days of Operation—Flywheel Motor-Generator Set Used

By B. M. JONES

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For the first time in the history of the American steel industry electric power has replaced steam on a large reversing blooming mill. Only two previous installations have been made in other countries to change from steam to electric power, and in one case the steam engine was left intact for emergency purposes.

On Dec. 7, 1920, the steam engine driving the 44-in. reversing blooming mill at the Steelton plant of the Bethlehem Steel Co. broke down. Work was started immediately to tear down the engine which, as had been previously planned, was to be replaced by electric drive. On Dec. 31 the company started to roll steel with the new electric motor. Considering the tremendous task of tearing down the large reversing steam engine, blasting out its foundations, building the forms for the motor foundations and installing the complete electrical apparatus in working order, the time taken—only 24 days—is considered remarkable.

Inasmuch as the blooming mill is the only one in the plant it was important that the change to the electric drive be made in the shortest time possible. In addition, it was also important that no time be lost in making adjustments or in tuning up a new equipment. To accomplish this it was necessary to have everything well organized and planned in detail so that there would be no unnecessary delay. The forms for the reversing motor foundation were built up complete in two pieces as a template before the engine was removed, and after the old foundation was blasted out these templates were set in position, the foundation bolts placed and the concrete immediately poured. This materially shortened the time required to make the change.

The motor rolled 609 tons of steel the first day, 796 the second and 1006 the third. The mill is now operating single turn and is in no way curtailing the output in spite of the fact that, due to shortage of power under the present condition, it is necessary to operate the equipment with a power demand not exceeding 2500 kw.

The electric drive consists of a double-unit reversing d-c. motor, the necessary flywheel motor-generator set for driving it and a small exciter

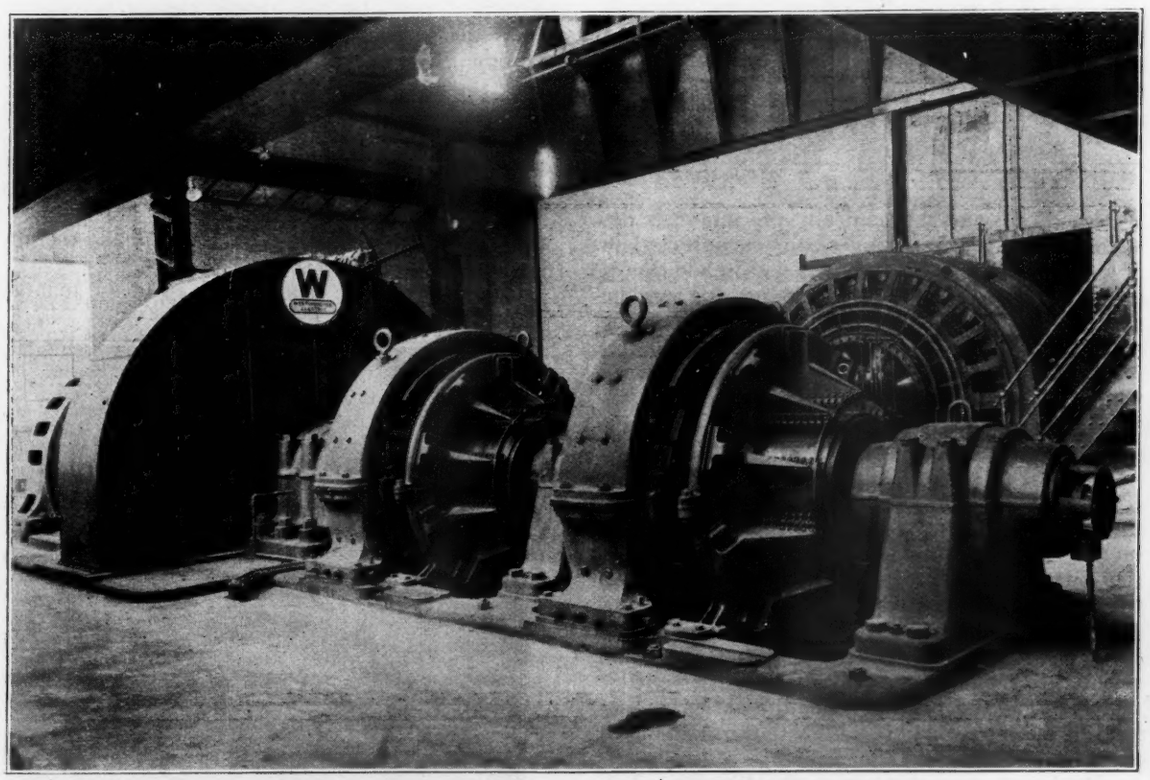


Fig. 1.—Flywheel Motor-Generator Set With Mill Motor Shown in Background.

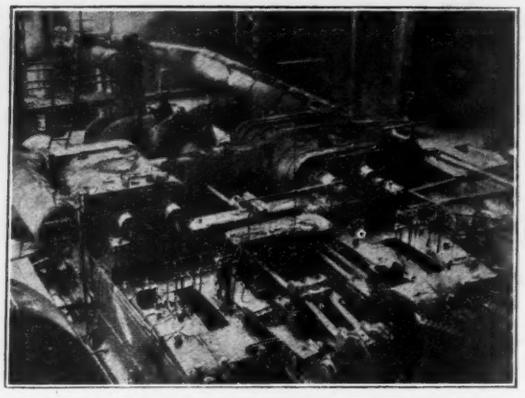


Fig. 2.—Twin Tandem Compound Reversing Engine That Was Replaced.

set, together with a blower outfit and the necessary switching equipment. All the machines except the blower outfit are mounted on the first floor of the motor room. The blower outfit is mounted in the basement and the switching equipment is mounted on a balcony. Lightning arresters are installed on the second balcony.

The double-unit reversing motor, as shown in the illustration, is a 600-volt, adjustable-speed, d-c. machine of the compound-wound compensated type, having a speed range of 0 to 120 r.p.m. in both directions. It is capable of developing 1,900,000-ft-lbs. torque momentarily and is directly connected to the mill. Each armature of this motor is mounted on the forged-steel shaft which is supported by two pedestal bearings arranged for water cooling and gravity oil lubrication. The bearings and frame of the motor are supported by a heavy cast-iron bedplate which is well anchored to the concrete foundation by long foundation bolts. The motor is semi-inclosed and is arranged for forced ventilation. The blower equipment, installed in the basement, is interlocked so as to prevent operation of the reversing motor in case the blower is not delivering the proper amount of cooling air.

Motor Designed to Withstand Overload Conditions.

Electrically and mechanically the motor is designed to withstand the overloads encountered in reversing blooming mill service, and in addition it is provided with a large thrust bearing on the pedestal nearest the mill to protect it from the mechanical shocks of the mill, such as the breaking of a spindle. The ease and rapidity with which this motor can be started, stopped and reversed shows it to be inherently adapted to reversing blooming mill service.

The motor is a compound-wound machine, the compounding being obtained indirectly by means of a small series exciter and a separate winding on the main poles of the reversing motor. Due to the extremely high peak currents encountered in the main circuit it would be extremely difficult to reverse the ordinary type of series field which would be necessary to keep the proper shunt and series-field relation. Therefore, the series exciter and the separate field is used, the series exciter field being connected in series with the main motor armature circuit, and the armature of the series exciter being connected across the separate winding of the main reversing motor.

The switches for reversing this field are operated from the master switch, which also operates the reversing switches in the field of the generator. By this means the compounding effect is obtained without the necessity of reversing the heavy armature current. This compounding of the reversing motor allows it to increase its torque on the overloads and thereby better meet the severe shocks that are encountered.

Construction Features of Flywheel Motor-Generator Set.

The reversing motor receives its energy from two 600-volt, 367-r.p.m. separately excited shunt-wound d-c. generators of the compensated type, which are designed to withstand the same peak loads as the reversing motor. These generators are driven by a 3200-hp. a-c. motor of the wound-rotor type, which is designed to operate on a 3-phase, 6600-volt, 25-cycle circuit. A 100,000-lb. flywheel is mounted on the same bedplate between the motor and generators. This flywheel is completely inclosed with a plate cover to reduce the windage losses and afford protection to the operator. The flywheel bearings of this set are arranged for gravity lubrication and for water cooling as an emergency feature.

A liquid slip regulator limits the peaks and equalizes the input to the flywheel set. When the load on the a-c. motor reaches a predetermined value the regulator introduces resistance in the secondary of the induction motor, which causes the flywheel set to slow down, thereby allowing the flywheel to give up a portion of its stored energy and thus absorbing the peak load. When the peak load is reduced the regulator cuts out the resistance in the secondary circuit of the induction motor and brings the flywheel set back to approximately full speed. The regulator is so arranged that the a-c. motor cannot be started until the maximum resistance is inserted in the secondary by means of the slip regulator being wide open. The switching equipment is so arranged that the flywheel set can be brought to rest within a short space of time by opening the forward primary oil circuit-breaker and closing the reverse primary oil circuit-breaker. This reverses one phase of the induction motor, causing it to exert a torque in the opposite direction and thereby bringing the set to rest quickly.

Special attention has been given to the manner

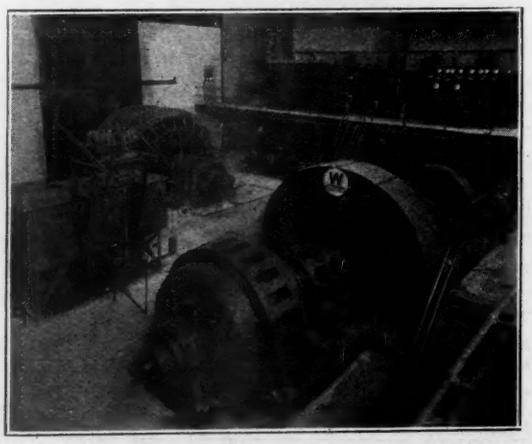


Fig. 3.—Motor-Room Substation Placed in Operation in Record Time.

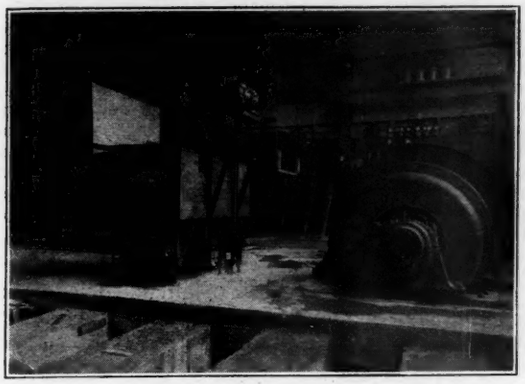


Fig. 4.—Slip Regulator and End View of Motor Generator.

of insulating these machines to withstand the dust and dirt usually encountered in a steel plant. The d-c. machines were designed with the object in view of being able to withstand the severe overload encountered in this class of service. The rapid change of flux in the poles requires careful design to eliminate commutation troubles from which these machines are particularly free. The design of a machine to handle this class of service involves many wide departures from previous practice, and the exceptional service that these machines have given is a good indication that they are liberally designed to withstand the abnormally severe conditions encountered.

Motor-Generator Control System Simple as Well as Effective.

The simplicity of this control equipment is clearly shown by the fact that the steam-engine operators rolled steel at the first trial without any trouble whatsoever. The operators seemed well pleased and surprised to find the ease with which the master switch was handled and the ready and sure response of the motor to the master switch.

The control of the main motor and generator is obtained by adjustment of the fields, the generator fields being reversed to obtain reverse direction of rotation of the main motor. The excitation of the motor shunt field remains in the same direction at all times. The speed of the reversing motor is proportional to the generator voltage up to normal voltage, and beyond that point the increase in speed of the reversing motor is obtained by weakening its main shunt field. The compound field, described previously, is adjusted to correspond with the speed of the reversing motor. The

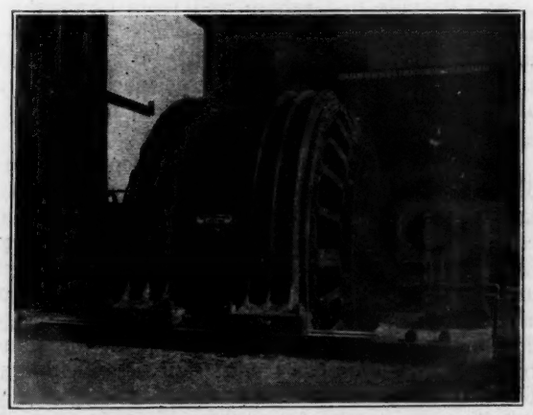


Fig. 5.—Side View of Reversing-Blooming-Mill Motor.

master switch is mounted in the mill for controlling the contactors which adjust the various field circuits of the motor and generators. The position of the master switch determines the speed and direction of rotation of the reversing motor. This system of control makes the operation of the equipment extremely simple while at the same time obtaining a rapid and effective means of control. Fig. 6 shows the schematic diagram of connection for this equipment.

The reversing motor and d-c. generators are separately excited, receiving their excitation from a small induction-motor-driven exciter set. The main d-c. circuit-breaker between the reversing motor and its generators is so interlocked that it cannot be closed unless the exciter set is operating properly.

Additional Equipment in Blooming Mill Motor Room Substation.

The motor room substation is used for synchronizing the two power houses, and there are installed on the first floor three 1000-kv-a. trans-

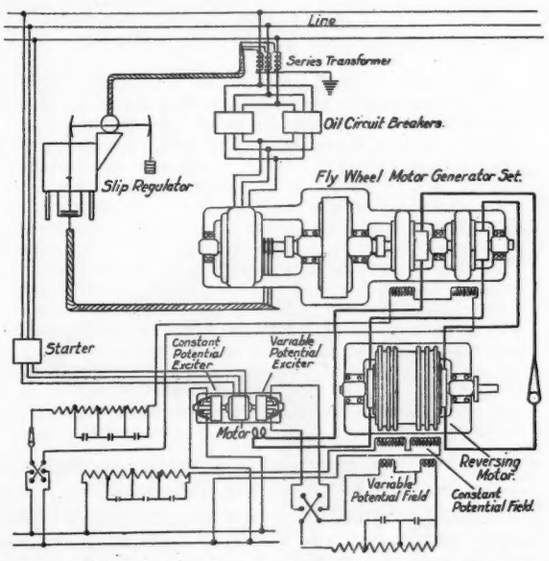


Fig. 6.—Schematic Diagram of Double-Unit Reversing-Mill Equipment.

formers having a ratio of 2200 to 6600 volts, through which the voltage of one power house is stepped up to the voltage of the second power house. The oil switch and synchronizing apparatus for synchronizing these two stations is located on the gallery. A double feeder system is brought to the gallery from one of the power plants, and usually these two feeders are used in parallel for supplying the induction motor of the flywheel motor-generator set.

A small transformer—6600 to 440 volts with a 220-volt starting tap—is used for supplying the power to the exciter set, blower and pump motors. As an emergency feature the Bethlehem Steel Co. have brought the 440-volt a-c. mill circuit into the motor room substation. This circuit will be used for driving the exciter set, blower and fan motors in case any trouble develops on the small transformer.

As a convenient and effective means of keeping some of the mill dust and dirt out of the motor room substation an additional duplicate blower equipment was installed in the basement and is

arranged in conjunction with the other blower, so that either equipment can be used to ventilate the room while the other is ventilating the reversing motor. This affords considerable means of protection in regard to keeping dust and dirt from settling in the motor room.

This motor room substation was laid out with the object in view of installing several motor-generator sets at some future date for supplying the d-c. power to the mill auxiliaries. At the present time these sets are not installed, but it is expected that they will be in operation in this substation.

JOINT POLE-LINE CONSTRUCTION. A CORRECTION.

Communications Presented to Clear Some Misunderstandings Relative to a Previously Published Article Upon This Subject.

In the Jan. 22, 1921, issue of ELECTRICAL REVIEW there appeared on p. 156 an article by H. B. Gear, entitled "Joint Pole-Line Construction in Chicago." The following quotation is reproduced from the body of that article:

> The most difficult problem in connection with joint arrangements in general is the desire of the electric company to use its poles for transmission lines at voltages above 5000. The Bell telephone engineers have objected to such an agreement, though contacts are often made by local telephone men on poles carrying circuits of over 5000 volts, presumably without official sanction. Objections of the telephone people are based upon the fear that their fuses will not protect their equipment in case a high-voltage circuit becomes crossed with a telephone wire. There is some reason to believe that the fuses will protect up to about 10,000 volts in most cases, and an agreement has been made in Pennsylvania by which the use of joint poles for circuits up to 13,200 volts may be permitted in cases where it is not practicable to build separate pole lines over different routes.

H. S. Warren, electrical interference engineer of the American Telephone and Telegraph Co., and Mr. Gear have had some correspondence relative to the contents of the above quotation, and have submitted the accompanying communications for publication to clear up any erroneous ideas that may have resulted from the presentation of the original article.

Editor of ELECTRICAL REVIEW:

In an article by H. B. Gear in the Jan. 22 issue of ELECTRICAL REVIEW, entitled "Joint Pole-Line Construction in Chicago," it is stated that while Bell telephone engineers object to the joint use of poles carrying circuits in excess of 5000 volts contacts on such poles are often made by local telephone men, presumably without official sanction.

As to this statement, I wish to say that the Bell companies' standard instructions and specifications definitely prohibit that practice, and our experience indicates that few, if any, departures are made from those standards.

The article also states that the telephone engineers' objections to high-voltage joint use are based on the fear that the fuses will not protect their equipment in case the high-voltage wires and telephone wires become crossed. That statement might imply that the limitation of fuses constitutes the only reason why such joint use is dangerous, which is not correct. While the inadequacy of the best available fuses or protective devices suitable for telephone systems is an important factor in the matter, the inherent complexity and necessary restriction of space and insulation of commercial telephone systems are elements as important as the fuse in determining what potentials may not be permitted on telephone circuits without undue hazard. Moreover, the more important thing is not the fear of injury to equipment, but injury to persons. In addition to the matter of personal hazard there would also be the serious question of inductive interference if poles were used jointly for high-tension circuits and telephone circuits.

The article further states that there is some reason to believe that the telephone fuses will protect up to about 10,000 volts in most cases. As a matter of fact, the evidence of experience and tests shows that reliance cannot be placed in such fuses for potentials in excess of about 2900 volts to ground (the potential to ground of a balanced, 3-phase, 5000-volt circuit).

(Signed) H. S. WARREN.

H. B. Gear, author of the original article, makes the following acknowledgment and correction:

Editor of ELECTRICAL REVIEW:

My attention has been drawn to a mis-statement in the paper read by me before the International Association of Municipal Electricians and printed in your issue of Jan. 22, 1921.

In one of the closing paragraphs it is stated that an agreement had been made between the Pennsylvania State Electric Association and the Bell telephone companies by which joint pole lines would be permitted at 13,200 volts, if the highways are occupied on both sides and no other route is available.

I now learn that this statement is premature in that, while the engineering specifications under which such work may be done have been agreed upon, the agreement proper is still uncompleted and is, therefore, not yet in effect.

Furthermore, the mention of 13,200 volts was made in such a way as to imply that that voltage was fixed as the limit. I am advised that no specific limiting voltage has been considered in connection with the negotiations on that agreement.

(Signed) H. B. GEAR.

TO BUILD POWER PLANT AND ELECTRIC RAILWAY IN TEXAS.

An extensive system of interurban electric railways is to be built by the Oil Fields Electric Railway Co., Eastland, Tex., which is being organized by W. Y. Fleming and associates. It is stated that there will be several trunk lines which will reach all of the principal cities and towns of Central West Texas. Preliminary surveys have been made for a line to run from Fort Worth to Cisco, through Graham, Breckenridge and other towns. Another line is to run from Wichita Falls to Abilene, through Stephenville and Brownwood. A branch line will run from Caddo to Ranger, thence through Eastland to Cisco. From Ranger a branch line will be built to Desdemona. From Cisco, lines will go to Hilburn, Rising Star, May and on to Brownwood. Another line from Cisco will run through Putnam, Baird to Abilene. From Caddo a main line will be run to Breckenridge and will branch off to Eliasville, through Ivan, from Eliasville to Graham and from Graham to Loving, Archer City to Wichita Falls. The principal offices of the company will be at Eastland and it is planned to build a large electric power plant near there for the operation of the system.

Illinois now has more than 500 separate telephone companies owned by about 80,000 security holders, the majority of them residents of the communities where the companies give service. Over 1,200,000 telephones are in use, or about one to each five inhabitants. As for Chicago, it alone numbers more telephones within the city confines than the total number used in the combined countries of England, France, Italy, Spain, Greece, Portugal and Norway. Chicago daily handles an average of 3,000,000 messages.

Protecting Lines Against Over-Voltage Surges

Hazards of Working on Live Circuits — Lightning and Switching Operations Produce Abnormal Line-Voltage Conditions — Use of Grounded Guard Wires and Horn Gaps—Arcing-Ground Dangers

By ALFRED STILL

In an article which appeared in ELECTRICAL REVIEW of April 2, 1921, various methods and devices for maintaining uninterrupted service on transmission systems were discussed. These included the automatic protection of duplicate lines and networks together with the modern developments in the contruction and use of current-limiting reactors. Before taking up in this article the important matter of protection against lightning and over-voltages generally, it is proposed to say a few words about the manner in which overhead lines are being maintained in good condition without interruption to service.

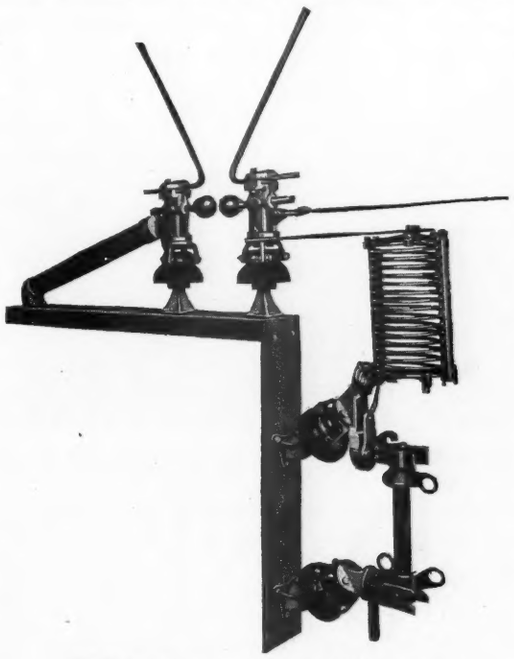
LOCALIZING FAULTS AND WORKING ON LIVE WIRES.

The procedure to be adopted in locating faults on an electric power system and in re-establishing interrupted service with the least possible delay will depend upon so many special and local conditions that no hard-and-fast rules can be made applicable to all transmission systems. The conditions in regard to grounded or ungrounded neutrals, transformer connections, positions of section switches, telephonic facilities, etc., are so variable that it is impossible to lay down any rules to be followed in emergencies, except in connection with a particular system; but such rules should be laid down by the chief operating engineer and rigidly adhered to. By giving careful attention to the position of patrolmen's houses and switching and telephone stations much may be done toward preventing long interruptions of service in the event of accidents.

A matter closely related to the maintenance of efficient and continuous service is the best means of detecting faults in insulators and replacing insulators without interruption to the supply. It is only of recent years that accurate data on the "life" of high-tension insulators is becoming available, and the continued action of alternate heat and cold, and dryness and dampness, on the porcelain—or rather on the complete assembly of porcelain, metal, and cement—is found to necessitate a very large percentage of replacements after a line has been in operation many years.

The causes of rapid deterioration—especially after several years of service—are being investigated and eliminated as far as possible in the later designs; but in the meanwhile lines that have been in use for a considerable time are giving trouble in the matter of insulation, involving increasing vigilance and activity on the part of the operating staff. There is room for improvement in the methods now available for detecting incipient faults in line insulators without interrupting the supply or disconnecting insulators from the live wires. Several methods have been tried, usually involving the use of a telephone receiver which gives audible indication of abnormal or defective conditions, and although improvements in the testing of insulators on live lines are to be looked for, such methods as are now in use are valuable in indicating the location of insulator units which should be replaced.

Many companies operating transmission lines now maintain them in proper condition by working on them while the wires are alive. Almost every kind of work can be done on live wires by using specially constructed tools and appliances. Defective insulators both of the pin and suspension type can be removed and replaced, wood poles can be changed and crossarms replaced, all without interruption to supply. The tools used differ somewhat, depending upon the type of insulator used on the line and the voltage, but all are provided with long insulating handles, usually of wood. Well seasoned white oak thoroughly dried and varnished appears to be one of the best materials for this purpose.



EEE Equipment for 13,200-Volt Service.

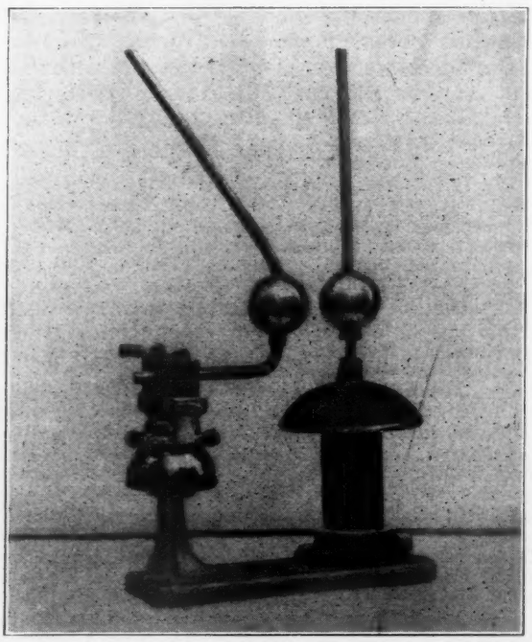
There is always an element of danger to the workers on systems where repairs and replacements are made on live wires, but the danger is least on the highest voltages where the clear-

ances between wires and between wire and grounded tower are greater than on the lower-voltage systems. It is simply a matter of having long enough handles to the tools, and the work when carried out by experienced men is not very dangerous. On the high-voltage lines the protection afforded by rubber gloves and shields or similar contrivances which afford reasonably good protection on 2200-volt distributing lines is not relied upon. The safety to the workers therefore depends upon the clearances between the live conductors and the supporting structure. Work on the high towers supporting 130,000-volt conductors is not very dangerous when proper precautions are taken; there is considerably more danger to life in working on lines using the pin type of insulator, especially with the relatively close spacing of conductors which is customary on circuits operating between 13,000 and 44,000 volts.

Protection of Lines Against Lightning and Over-voltages.

Overhead lines are very liable to be influenced by static electricity in the atmosphere. Apart from the possibility of a direct lightning stroke the line will accumulate electrostatic charges when charged clouds are passing overhead; also through contact with rain drops, snow, or even mist. The reaction which occurs when lightning discharges from cloud to cloud, or from cloud to earth in the neighborhood of an overhead line, results in a sudden rise of potential caused by the release of the induced charge. A high-potential disturbance or wave-pulse then travels along the line and may discharge to ground over insulators or through apparatus connected to the line unless a suitable path is provided through a lightning arrester.

Pressure surges and oscillations may also be set up by suddenly switching a source of electrical energy on or off a long transmission line. The relation existing between the voltage and the current of any transient electrical disturbance occurring in a circuit depends upon the relation between the magnetic flux-linkages per unit current—or the inductance—and the permittance or electrostatic capacity. Unfortunately the calculations of the probable surges or oscillations are not easily made, and, moreover, accurate data concerning the characteristics of the various circuits and apparatus connected to the system are rarely available. The accuracy of such calculations depends largely upon the value of what is called the *surge impedance* of the line and apparatus connected thereto. This is the quantity $\sqrt{L/C}$ where L stands for the inductance of the circuit and C is its permittance or electrostatic capacity.



Sphere-Gap Arrester With Series Resistance Connected in Circuit.

There is frequently danger of abnormally high voltages due to surges at the points where there is a change in the constants of the circuit. Thus, if a transformer is connected across the ends of a long overhead transmission line there will be a rise of pressure when a travelling wave arrives at this point, because the surge impedance, $\sqrt{L/C}$, of the transformer winding may be between 2000 and 4000 ohms, which is very much higher than that of the line itself (about 400 ohms). It is for this reason that the end turns of transformer primaries are specially insulated to withstand much higher voltages between turns than the remainder of the winding.

In the case of a change from underground to overhead transmission a surge originating in the cable will produce a rise in pressure at the junction with the overhead line, while the contrary will occur (i. e., the voltage will be reduced) if the surge is originated in the overhead line and passes into the cable system of which the surge impedance will always be smaller than that of the overhead transmission. With the good insulation provided on modern high-voltage systems it is doubtful if the interruption of the current by opening switches under load is likely to cause serious voltage disturbances, except in the case of air-break switches where a long arc may be formed and suddenly interrupted—as, for instance, by a draught of air—when the current is of considerable value. Oil-break switches almost invariably open the circuit at the instant when the current is passing through zero value. Whatever device is installed to provide a path whereby the high-potential charges on the line may pass to earth it is evidently necessary that means be provided to prevent the discharge being followed by a power arc maintained by the working potential of the system. Over-voltages up to 40% in excess of the normal line voltage can be produced by switching-in a long line. High-frequency impulses or surges are set up which, in the special case of an arcing ground, may give rise to a destructive series of surges—a state of things which will continue until the fault is removed. An arrestor which may be suitable for dealing with transitory lightning effects may be quite inadequate to dissipate the charges built up by such continual surges.

Danger Resulting From an Arcing Ground on Lines.

The high-frequency oscillations between capacity and inductance which are started by a

lightning discharge or some abnormal condition in the system itself may result in periodic or recurring high-frequency oscillations continuing for a considerable length of time. An arcing ground on a transmission line is a case in point. The ordinary types of lightning arrester will not take care of such a condition, because they cannot continue to dissipate the energy supplied by the generators on a large transmission system for any considerable length of time. It is therefore necessary to provide some kind of arrester which does not discharge at pressures below the power voltage, but only relieves the system of overvoltages—sometimes an automatic device known as the arcing ground suppressor will give good protection. This is an automatic device for momentarily short-circuiting the arc through a switch. By providing a metallic connection between the conductor and ground the arc is suppressed, and it will usually not reform when the switch is again opened because the air in the path of the arc has had time to cool and the line pressure which was sufficiently high to maintain the arc once started is not able to break down the insulation of the new layers of cooler air. Automatic switches are provided which will connect any one conductor to ground during the very short time necessary to allow the arc to clear itself. The principal feature of the device is the selective relay which will energize the solenoid operating the switch on the faulty line. When the relay operates, the switch between line and ground is momentarily closed. On reopening, a suitable resistance is inserted before the final break to prevent the creation of oscillating currents in the line.

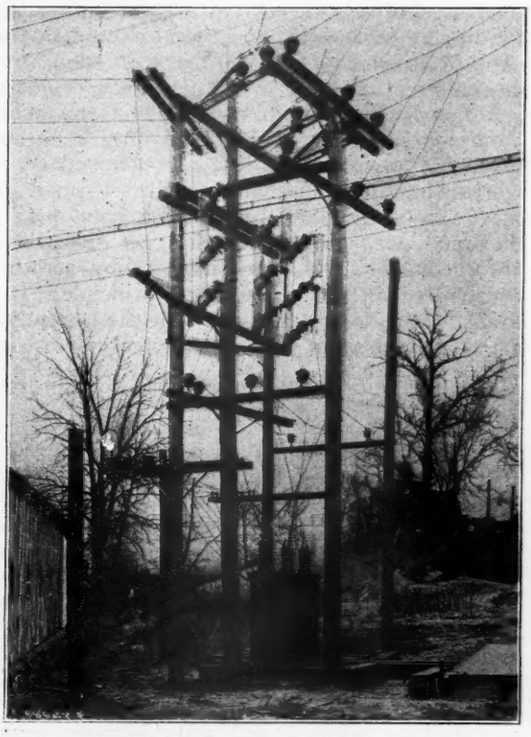
Use of the Grounded Guard Wire With Overhead Lines.

Although engineers are still divided in opinion as to the value of the protection afforded by overhead grounded guard wires carried the whole length of the line above the conductors, it is now generally recognized that this method of protection is efficient. The objections to the guard wire are the additional cost and the possibility of the grounded wire breaking and falling across the conductors below, thus causing an interruption to continuous working. Trouble due to this cause is, however, exceedingly rare.

In regard to the position of overhead guard wires relative to the conductors it is obvious that a number of grounded wires surrounding the conductors will afford better protection than a single wire above the conductors, and two guard wires are sometimes provided; but the additional cost is rarely justified. Perfect protection cannot be obtained even with two guard wires, and cases have been reported of lightning missing the grounded wire and striking a conductor situated immediately below it. Although it is possible that a ground wire may sometimes cause a direct lightning discharge which otherwise might not have struck the line, the grounded guard wire is generally looked upon as having advantages which justify the increased cost. It usually consists of a galvanized Siemens-Martin steel cable, although a single wire is satisfactory on the smaller and less important lines. Copper-clad steel is sometimes used, not because of its higher conductivity, but because under unfavorable atmospheric conditions it will last longer than galvanized steel. The guard wire must be well grounded at frequent intervals, preferably at every pole, but at least every 500 ft. even in wet or marshy ground. Even if the guard wire is omitted on many high-voltage transmission lines its use on medium and low-voltage lines appears to be well established.

Means of Protecting Insulators From Power Arcs.

When an overvoltage occurs on a line insulator, causing a discharge between the conductor and the supporting arm on the pole or tower, it is important that the heat of the power arc following the flash-over should not crack or break the porcelain of the insulator. The provision of two metal rings of suitable diameter, one clamped near the top of the insulator and the other near the bottom and connected respectively to the line wire and grounded insulator pin or link, will cause the arc to jump from ring to ring and so clear the insulator. Metallic projections or arcing horns may take the place of rings, the object of these devices being not merely to provide a path for the high-voltage flash-over, but also to reduce the concentration of potential at the points where the metal fittings are attached to the porcelain and thus reduce the risk of puncture at these points.



33,000-Volt Substation, Showing Horn Gaps at Pole Tops.

Before considering the different types of lightning arresters at present in use on overhead systems it may be well to point out that a simple spark gap between line and ground will afford protection from lightning disturbances, provided there is no possibility of a power arc following the discharge. Obviously the simple spark gap will not be suitable for use on power lines. It may be adapted for use on power circuits by

providing a magnetic blow-out to extinguish the power arc, as in some forms of arrester now in use on overhead d-c. circuits (electric railways), or the principle of the horn gap may be used on a-c. circuits. This is satisfactory under certain conditions, but a better solution of the lightning problem is to be found in the multigap arrester which gives good protection on medium-voltage a-c. circuits provided the electrostatic capacity of the system is small. On large high-voltage power lines the short-circuit power arc following the discharge may be sufficient to destroy almost any type of spark-gap arrester in a fraction of a second, or even a fraction of cycle. If a resistance is put in series with the ground connection the short-circuit current may be limited, but the discharge capacity and therefore the amount of protection afforded will be reduced accordingly.

On modern high-voltage systems, including hundreds of miles of overhead lines connected through transformers to extensive secondary net works, lightning discharges will set up high-frequency oscillations between capacity and inductance which cannot readily be diverted or absorbed by simple spark gaps or by arrestors constructed on the multiple-gap principle. It is to deal with these conditions that the electrolytic arrester and certain forms of condenser are used.

Horn-Gap Lightning Arrester Construction and Operation.

The horn-gap arrester is so well known that it requires no detailed description. When the potential rises to such a value that it can jump the gap at the base of the curved wires the power arc will follow the discharge, but, owing partly to the upward tendency of the heated air and, mainly, to the magnetic field produced by the current itself, the arc is driven upward toward the ends of the "horns" where, after being sufficiently drawn out in length, it is finally ruptured. The horn gap is not effective when set to discharge at pressures below 13,000 volts, because, with a small gap (less than 1 in.), the arc may not rise and break properly.

Ground connection should be made through a noninductive resistance. If no resistance is provided in the ground connection the momentary discharge of the power current may be excessive, dangerous surges may be set up in the line, and there is the possibility of synchronous machines being thrown out of step. Experience is the best guide in arriving at the most effective value of the resistance in the ground connection. It is evident that an appreciable amount of resistance is desirable, but that too high a resistance will allow insufficient current to pass to ground and may stand in the way of the rapid extinction of the arc across the horns. In deciding upon the best value the effect of the power arc following the discharge must be considered. The current must be limited to an amount which will not put too severe a load on the system.

One objection to the horn-gap arrester is the liability of an intermittent arc setting up surges and high-potential disturbances in the neighborhood of the discharge to ground, but, nevertheless, horn arresters when provided at the proper place on the system and intelligently installed with the necessary resistances and gap adjustments afford good protection on both a-c. and d-c. circuits. They are frequently used on systems operating at pressures between 13,000 and 33,000 volts, but they are also installed for the protection of transformers and other apparatus, especially in connection with outdoor substations, for pressures up to 80,000 volts and even higher.

One recent improvement in this type of arrester is the provision of a sphere gap across which the first discharge occurs. The arc rising above the spheres is carried upward and broken by the horn gaps in the usual way. The sphere gap is much more rapid in its action than the gap between wire horns, and has proven itself superior for discharging high-frequency surges to ground. The illustration from a photograph supplied by the Electrical Engineers' Equipment Co. shows the sphere gap together with choke coil and switch-fuse as used for the protection of small branch lines.

In a succeeding article other forms of lightning arresters will be described, and the subject of protection against over-voltages and high-frequency disturbances will be concluded.

MOTION-PICTURE ENGINEERS WILL MEET IN WASHINGTON.

The 12th convention of the Society of Motion Picture Engineers will be held at Hotel Raleigh, Washington, D. C., May 9-12. The president of the Society, H. A. Camps, commercial engineer, specializing on motion-picture equipment for the Westinghouse Electric & Manufacturing Co., will preside at the convention. In addition to the sessions to be held at the Hotel Raleigh, other sessions will be held at the Bureau of Standards, the National Museum and Department of Interior. Men representing the motion-picture industry from all over the United States and Canada will attend this convention. Plans are on foot to adopt some new forms and regulations for the betterment of the motion-picture industry.

The following papers will be read: "Continuous Motion Picture Projection and Taking of Pictures at High Speed," by C. Francis Jenkins, Washington, D. C.; "New Developments in Incandescent Lamp Projection," by C. A. B. Halverson, Lynn, Mass.; "Smoke Box Demonstration of Lens Action," by F. H. Richardson, New York City; "Theatre Lighting," by J. L. Spear, New York City; "Motion Picture Cameras," by Carl L. Gregory, New York City; "Animated Cartoons," by J. R. Bray, New York City; "Analysis of Motion," by Charles P. Watson, New York City; "Industrial Mechanographs," by Harry Levy, New York City; "The Action of Various Chemicals on Arc Lamps' Cores," by Dr. W. R. Mott, Cleveland; "Building a Non-Theatrical Library," by L. E. Davidson, Buffalo, N. Y., and "Colored Toning of Cine Films," by F. E. Ives, New York City.

A lecture on "The Motorship: Its Economic Position With Reference to the Oil-fired Turbine Steamer," by Charles E. Lucke, Ph. D., professor of mechanical engineering, Columbia University, New York City, was the feature of a recent meeting of the Franklin Institute of the State of Pennsylvania. The lecture was illustrated by lantern slides.

Balance-Factor in the Solution of Power Problems

Determination of Power-Factor Is Difficult Where Loads Are Unbalanced on Various Sides or Phases of Circuit—Problems Worked Out for Different Types of Systems and Conditions

By HERBERT B. DWIGHT

In making up a definition for power-factor of a polyphase circuit one is immediately brought face to face with the question of balance. There is a strong appeal in that definition of power-factor which always treats a pure resistance load of 100% power-factor, irrespective of the degree of balance between the phases, when the alternating currents and voltages are of sine-wave form. This definition of power-factor, however, does not indicate the great disadvantage suffered by reason of lack of balance between the phases, which is becoming of considerable commercial importance. There is, therefore, a clear demand for a concise, correct and practical definition of the balance-factor of the load of a customer or of an entire system.

One desirable feature of a definition of balance-factor is that it be simple enough to be expressed as a plain percentage, so that one can say that a certain 3-phase load has 90% balance-factor in the same way that one can say that it has 80% power-factor, or 40% load-factor. It is also desirable that a definition of balance-factor be applicable to any symmetrical type of circuit which may become unbalanced, such as a 3-phase ungrounded circuit, a 3-phase circuit with grounded neutral conductor, or a single-phase or d-c. circuit with neutral conductor.

No definition of balance- or unbalance-factor, expressed as a simple percentage, has been proposed which can describe completely the characteristics of an unbalanced load so that all problems connected therewith can be solved. It appears that no such simple definition can be formulated, for the balance between the phases depends not only on the numerical ratios between the voltages and currents, but on their phase relations as well.

It may be accepted, therefore, that a definition which expresses the balance-factor as a simple percentage, while very valuable from a commercial point of view in connection with energy contracts, can be expected only to indicate, in general, the degree of balance between the phases. It cannot be expected to give a full description of an unbalanced load for all mathematical purposes. It should, however, respond sensitively to changes in balance which affect the welfare of electrical equipment. For instance, the definition ought not to neglect entirely the effects of phase relations.

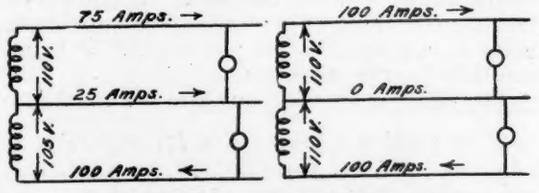


Fig. 1.—Single-Phase or Direct-Current Circuit With Neutral Conductor.

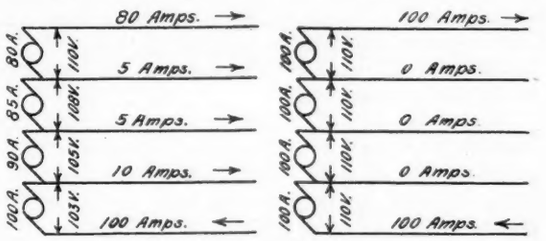


Fig. 2.—Five-Wire Direct-Current Circuit.

A percentage given by the definition should stand definitely for a certain degree of disadvantage due to lack of balance between phases.

The following definition of balance-factor proposed by the writer is simple and straightforward to explain to nontechnical users of electric energy, so that it can be used for incorporation in energy contracts:

"The balance-factor in an unbalanced circuit is the ratio of the volt-amperes in the unbalanced circuit to the volt-amperes in a balanced symmetrical circuit of the same kind, whose voltage between conductors adjacent in phase or voltage is equal to the highest voltage between any two conductors adjacent in phase or voltage in the unbalanced circuit, and whose current per conductor is equal to the greatest current in any of the conductors of the unbalanced cricuit. This applies to direct current, single-phase and polyphase circuits. This refers strictly only to cases where the voltage and current are both sinusoidal and to direct-current circuits."

The above definition for balance-factor depends on the value of the volt-amperes in an unbalanced circuit; that is, on the value of the power-factor in an unbalanced circuit. While these quantities have been defined for single-phase circuits, there is as yet no official method of calculating the total volt-amperes or the power-factor in an unbalanced polyphase circuit.

The "vector sum" definition of power-factor has been strongly advocated by a large number of engineers and seems to be the most logical from every point of view. It is the definition referred to in the first paragraph of this article, and it gives 100% power-factor for the pure resistance load with sine-wave current and voltage. It is as fol-

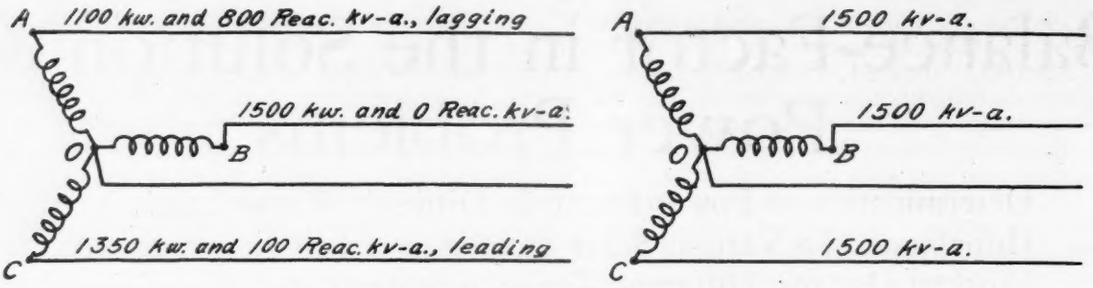


Fig. 3.—Three-Phase Circuit With Neutral Conductor.

lows: "Power-factor in a polyphase circuit is the ratio of the total watts to the vector sum of the volt-amperes in the several phases."*

It may be observed from the definition of balance-factor given above that line conditions only are to be considered. In a 3-phase circuit the currents in the conductors of the circuit are to be considered and not the currents in a delta-connected bank of transformers. The currents in star-connected apparatus may be used in the calculations, since they are the same as the currents in the line conductors.

A concise way of stating the definition of balance-factor given above is that balance-factor is equal to the ratio of the actual kv-a. of an unbalanced load, to the balanced kv-a. rating of the circuit (such as underground cables) which must be provided.

The definition of the balance-factor is easily applied to a great many different types of circuits, as is indicated by the following examples:

(1) *Single-phase or direct-current circuit, with neutral conductor.*—In this case, as shown in Fig. 1, the total volt-amperes of the unbalanced load are $(75 \times 110) + (100 \times 105) = (8250 + 10{,}500) = 18{,}750$ volt-amperes. The volt-amperes of the balanced load are $(2 \times 100 \times 110) = 22{,}000$ volt-amperes. The balance-factor is $18{,}750/22{,}000 \times 100 = 85.2\%$.

(2) *Five-wire direct-current circuit.*—In this case, as shown in Fig. 2, the total volt-amperes, or watts, of the unbalanced load amounts to $(80 \times 110) + (85 \times 108) + (90 \times 109) + (100 \times 103) = 8800 + 9180 + 9450 + 10{,}300 = 37{,}730$ watts. The watts of the balanced load amount to $(4 \times 100 \times 110) = 44{,}000$ watts. The balance-factor is $37{,}730/44{,}000 \times 100 = 85.8\%$.

(3) *Three-phase circuit with neutral conductor.*—In this case, as shown in Fig. 3, the total kilowatts of the unbalanced load are $(1100 + 1500 + 1350) = 3950$ kw. The total reactive kv-a. of the unbalanced load is $(800 + 0 - 100) = 700$ reactive kv-a. lagging. Leading reactive kv-a. are opposite in sign to lagging reactive kv-a.

The total kv-a. of the unbalanced load amounts to $\sqrt{(3950)^2 + (700)^2} = 4010$ kv-a. The total kv-a. of the balanced load amounts to $(3 \times 1500) = 4500$ kv-a., the kv-a. in all phases of the balanced load having the same power-factor. The balance-factor is $4010/4500 \times 100 = 89.1\%$.

It is interesting to continue this calculation a little in order to obtain the power-factor of the unbalanced 3-phase load. The power-factor is $3950/4010 \times 100 = 98.5\%$, lagging. This method of calculating kv-a. and power-factor is in accordance with the "vector sum" definition. It applies also to a polyphase circuit without neutral conductor.

(4) *Three-phase circuit without neutral conductor.*—In this case, as shown in Fig. 4, the numerical calculation of this problem is exactly the same as for Fig. 3, and the same values of balance-factor and power-factor are obtained. As shown later, the location of O on the potential diagram is immaterial so far as the total kw. and kv-a. are concerned. For instance, for convenience in measurement, O may be located at A, B or C, in which case the readings would not be nearly equal, as they are in Fig. 4. It may be mentioned that this principle is used in the well-known two-wattmeter method of measuring power, O being located at one of the line terminals such as A, B or C.

(5) *Two-phase and six-phase circuits.*—If there is a neutral conductor the load in each line conductor measured to the neutral conductor must be determined and the calculation proceeded with as in case 3. If there is no neutral conductor the loads must be measured to some assumed point, the potential of which is immaterial for the purpose of calculating balance-factor and power-factor.

The following will show that the value of the total reactive volt-amperes in an unbalanced 3-phase circuit without neutral conductor, when measured from each conductor to a point O and added together, algebraically, having regard to whether they are lagging or leading, is independent of the position of the reference-voltage point O, the currents and voltages having sine-wave form: Let the three conductors be A, B and C, and the three currents be I_1, I_2 and I_3, whose magnitude and phase are shown in Fig. 5. Since there is no neutral conductor the vector sum of the three currents is zero; that is, if they are plotted end to end the three vectors form a closed triangle as in AFG. Let the positions of A, B and C in the diagram, Fig. 5, represent the relative potentials of the conductors, A, B and C from each other. Let O be the point of reference. Draw ON, OS and OT perpendicular to I_1, I_2 and I_3. ON is the component of the voltage OA which is in quadrature with the current I_1. Therefore the reactive volt-amperes in phase A, measured to the point O, are equal to the product $ON \times I_1$, and similarly for the other phases.

The total reactive volt-amperes are equal to

$$\begin{aligned} Q &= (ON \times I_1) + (OS \times I_2) + (OT \times I_3) \\ &= (ON \times I_1) + (LS \times I_2) - (OL \times I_2) \\ &\quad + (OM \times I_3) - (MT \times I_3) \end{aligned}$$

Now, LS and MT are independent of the posi-

*Definition 2, Preliminary Report of the Special Joint Committee on Power-Factor in Polyphase Circuits, Journal A. I. E. E., page 538, June, 1920.

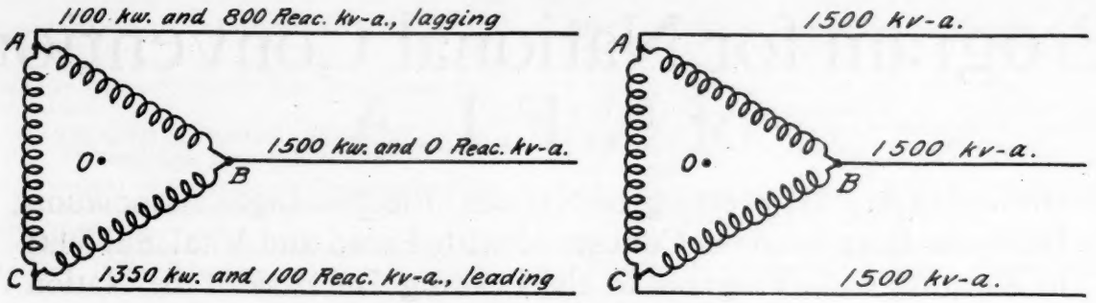


Fig. 4.—Three-Phase Circuit Without Neutral Conductor.

tion of O, since they are the perpendicular distances between fixed parallel lines. Therefore,

$$Q + \text{constant} = (ON \times AF) + (OM \times GA) - (OL \times FG) = 2(\triangle OAF + \triangle OGA - \triangle OFG) = -2 \times \triangle AGF$$

which is independent of the position of O. The proof for other numbers of phases is similar.

The following will show that the value of the power in an unbalanced 3-phase circuit without neutral conductor, when measured from each conductor to a reference-voltage point O and added together is independent of the position of the point O, the currents and voltages having sine wave form: In Fig. 5, NA is the component of the voltage OA which is in phase with the current I_1. Therefore the power in phase A, measured to O, is equal to $NA \times I_1$, and similarly for the other phases. The total power is equal to $P = (NA \times I_1) + (SB \times I_2) + (TC \times I_3)$, and $P + \text{constant} = (NA \times I_1) - (FL \times I_2) - (GM \times I_3)$, where the constant is independent of the position of O. Therefore, $P + \text{constant} = (AN \times AF) - (FL \times FG) - (GM \times GA)$.

Now, $(OA)^2 - (ON)^2 + (OF)^2 - (OL)^2 + (OG)^2 - (OM)^2 = (OF)^2 - (ON)^2 + (OG)^2 - (OL)^2 + (OA)^2 - (OM)^2$.

Therefore, $(AN)^2 + (FL)^2 + (GM)^2 = (FN)^2 + (GL)^2 + (AM)^2$, and $(AN)^2 - (AN \times NF) + (FL)^2 - (FL \times LG) + (GM)^2 - (GM \times MA) = (FN)^2 - (AN \times NF) + (GL)^2 - (FL \times LG) + (AM)^2 - (GM \times MA)$.

That is, $-(AN \times AF) + (FL \times FG) + (GM \times GA) = (AF \times FN) - (FG \times GL) - (GA \times AM) = \frac{1}{2}[(AF)^2 + (FG)^2 + (GA)^2]$, since $-(AN \times AF) + (FL \times FG) + (GM \times GA) + (AF \times FN) - (FG \times GL) - (GA \times AM) = (AF)^2 + (FG)^2 + (GA)^2$.

This latter quantity is independent of the position of O.

Now, as shown above, $P + \text{constant} = (AN \times AF) - (FL \times FG) - (GM \times GA)$, and therefore, the value of P is independent of the position of O. The proof for other numbers of phases is similar.

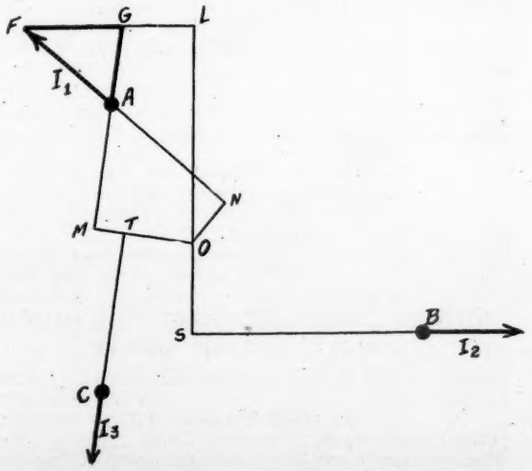


Fig. 5.—Vector Diagram of Three-Phase Circuit.

TO DEMONSTRATE ELECTRIC HEAT FOR INDUSTRIAL USES.

A demonstration of the great advance which has been made during the last few years in electric heating will be presented at the showrooms of The New York Edison Co., Irving place and 15th street, New York City, June 6-11. Equipment for both home and industrial purposes will be shown. The marked progress that has been made in the application of electric power and light is rapidly being duplicated in the application of electricity as a source of heat. What the labor-saving devices for the home have done in lessening the work in the household, industrial appliances are now accomplishing in the workshop and factory or any place where heating is required. Self-contained units in several sizes for localized heating will be shown. These are rated for different degrees of heat and very high temperatures can be produced in any given space. Tubular heaters for heating oils, paraffin, and other inflammable liquids where an exposed flame is dangerous will be shown. Electric heating apparatus for candy makers, shoe factories, and the many industries which use heat, will be exhibited and demonstrated, as well as ovens, ranges, soldering irons, branding irons, can capping tools, and glue pots.

Exhibitors at Electric Heating Show.

Aqua Water Heater Co.; American Electric Heater Co.; Western Electric Co.; Boston Last Co.; Bramhall Deane Co.; Cutler-Hammer Manufacturing Co.; Mergenthaler Linotype Co.; Duparquet Huot & Moneuse; Detroit Electric Branding Iron Co.; General Electric Co.; Hughes Electric Heating Co.; Edison Electric Appliance Co.; Hoskins Manufacturing Co.; M. Kirschberger & Co.; H. Griffin & Co.; Jaburg Brothers; Landers Frary & Clark; Manning Bowman Co.; National Electric Supply Co.; Prometheus Electric Co.; Reimers Manufacturing Co.; Reutenber Electric Co.; Rice & Lawler; Strite Automatic Toaster Co.; Vulcan Electric Heating Co.; Westinghouse Electric & Manufacturing Co.; Simplex Electric Heating Co.; Waage Electric Co.; Standard Stove Co.; American Insulator Co.; American Lava Corp.; Johns Manville Co.; Auto Electric Heater Co.; Alpha Electric Supply Co.; L. Barth & Co.; Driver Harris Co.; Electric Alloy Co. and the International Electric Co.

Program for National Convention of N. E. L. A.

Outline of Annual Meeting of National Electric Light Association Indicates Busy Sessions Concerned with Broad and Vital Subjects in Keeping with Progress in the Leading Industry of the Nation

Progress in the electrical industry will be reflected as never before in the reports and subjects to be discussed at the 44th convention of the National Electric Light Association, to be held at the Hotel Drake, Chicago, May 31-June 3. A tentative draft of the program has been prepared, subject to some minor changes before the opening of the convention.

Carefully selected subjects have been systematically scheduled so that matters of broad, major importance will be presented at the morning general sessions, while the more specialized subjects will receive detailed consideration in the afternoon sessions of the four sections of the Association. There will be four general and executive sessions and 15 distinct sessions of the four sections during the four days of the convention. Because of the length of their program two of the sections will divide and hold parallel sessions. Since the last convention there have been some changes in the names and obligations of the various sections. The work of the old electric vehicle section has been absorbed by one of the other sections and the Public Relations Section has become one of the most important of the Association.

FIRST GENERAL SESSION.
Tuesday, May 31, 9:30 a. m.

Address, "Welcome to Chicago." Speaker to be selected.
Address by President Martin J. Insull.
Appointment of committee on president's address.
Report by H. C. Abell, treasurer.
Report by M. H. Aylesworth, executive manager.
Address by chairman of Accounting Section, J. C. Van Duyne, Brooklyn Edison Co.
Address by chairman of Commercial Section, M. S. Seelman, Jr., Brooklyn Edison Co.
Address by chairman of Public Relations Section, J. E. Davidson, Nebraska Power Co., Omaha.
Address by chairman of Technical Section, I. E. Moultrop, Edison Electric Illuminating Co. of Boston.
Report of Committee on Constitution and By-Laws by Chairman W. C. L. Eglin, Philadelphia Electric Co.

TENTATIVE SCHEDULE OF SESSIONS, FORTYFOURTH CONVENTION, NATIONAL ELECTRIC LIGHT ASSOCIATION, CHICAGO, MAY 30-JUNE 3, 1921.

	Monday, May 30.	Tuesday, May 31.	Wednesday, June 1.	Thursday, June 2.	Friday, June 3.
Morning.	9:30 a. m.—Registration.	9:30 a. m.—General Session No. 1.	9:30 a. m.—General Session No. 2.	9:30 a. m.—General Session No. 3.	9:30 a. m.—General Session No. 4.
Afternoon.		1:00 p. m.—National Executive Committee and Luncheon. 2:15 p. m.—Accounting Section—Session No. 1. Commercial Section—1st Parallel Session. Technical Section—1st Parallel Session. 2:30 p. m.—Commercial Section—1st Parallel Session. 4:00 p. m.—Technical Section—1st Parallel Session.	2:00 p. m.—Commercial Section—2nd Parallel Session. 2:15 p. m.—Accounting Section—Session No. 2. Commercial Section—2nd Parallel Session. Technical Section—Session No. 2. 2:30 p. m.—Public Relations Section — Session No. 1.	12:00 m.—Electric Vehicle Bureau Luncheon. 1:00 p. m.—Public Policy Committee—Luncheon. 2:15 p. m.—Accounting Section—Session No. 3. Commercial Section—Session No. 3. 2:30 p. m.—Technical Section—3rd Parallel Session.	
Evening.	8:30 p. m.—Accounting Section — Executive Committee Meeting. Commercial Section — Executive Committee Meeting. Public Relations Section — Executive Committee Meeting. Technical Section—Executive Committee Meeting.	9:00 p. m.—Reception by President Martin J. Insull.		8:30 p. m.—Public Policy Committee Meeting.	

Election of Committee on Constitutional Revision.
Announcements.
Report (printed) of Committee on Membership by Chairman Walter Neumuller, New York Edison Co.
Adjournment.

SECOND GENERAL SESSION.
Wednesday, June 1, 9:30 a. m.

Report (printed) of Committee on Company Employes' Organizations by Chairman David Darlington, New York Edison Co.
Report of Committee on Rate Research by Chairman Alex Dow, Detroit Edison Co.
Report of Committee on Constitutional Revision.
Vote on Proposed Constitutional Amendments.
Election of Nominating Committee.
Address (general subject—Power), by Samuel Insull, Commonwealth Edison Co., Chicago.
Appointment of Committee on Memorials.
Appointment of Committee on Resolutions.
Address (subject to be selected), by Hon. James A. Perry, president, National Association of Railway and Utility Commissioners, Atlanta, Ga.
Report of Public Policy Sub-Committee on Inductive Interference, by R. H. Ballard, Southern California Edison Co., Los Angeles.
Announcements.
Report on "Super Power Survey" by Charles L. Edgar, Edison Electric Illuminating Co. of Boston.
Report of Lamp Committee by Chairman Frank W. Smith, United Electric Light & Power Co., New York City.
Report (printed) of Wiring Committee by Chairman R. S. Hale, Edison Electric Illuminating Co. of Boston.
Adjournment.

THIRD GENERAL SESSION.
Thursday, June 2, 9:30 a. m.

Report (printed) of Committee on Insurance by Chairman S. E. Wolff, Hodenpyl, Hardy & Co., Inc., New York City.
Report (printed) of Committee on Electrical Resources of the Nation by Chairman M. S. Sloan, Brooklyn Edison Co.
Report (printed) of Committee on Water Power Development by Chairman Franklin T. Griffith, Portland Railway, Light & Power Co., Portland, Ore.
Address (subject and speaker to be selected).
Announcements.
Address, "The Electric Vehicle," by Arthur Williams, general commercial manager, New York Edison Co.
Address (subject and speaker to be selected).
Report of Committee on Co-operation With Other Associations by Chairman Sidney Z. Mitchell, Electric Bond & Share Co., New York City.
Report (printed) of Committee on Accident Prevention by Chairman Charles B. Scott, Bureau of Safety, Chicago.
Adjournment.

FOURTH GENERAL SESSION.
Friday, June 3, 9:30 a. m.

Report of Committee on Doherty and Billings Prizes by Chairman A. S. Loizeaux, Consolidated Gas, Electric Light & Power Co., Baltimore.
Report of Committee on Exhibition by Chairman C. L. Peirce, Jr., Hubbard & Co., Inc., Pittsburgh.
Report of Committee on Electrification of Steam Railroads by Chairman Louis A. Ferguson, Commonwealth Edison Co., Chicago.
Address (general subject—Customers' Ownership) by John F. Gilchrist, vice-president, Commonwealth Edison Co., Chicago.
Address (subject and speaker to be selected).
Report of Committee on President's Address.
Report of Committee on Memorials.
Report of Committee on Resolutions.
Report of Nominating Committee.
Election and installation of officers.
Adjournment.

ACCOUNTING SECTION—FIRST SESSION.
Tuesday, May 31, 2:15 p. m.

Address by Section Chairman J. C. Van Duyne, Brooklyn Edison Co., Inc.
Appointment of Nominating Committee.
Report (printed) of Committee on Accounting Education by Chairman Fred R. Jenkins, Commonwealth Edison Co., Chicago.
Report (printed) of Committee on Classification of Accounts, Reports to Commissions and Relations with Other Associations by Chairman W. J. Meyers, United Electric Light & Power Co., New York City.
Report (printed) of Committee on Purchasing and Storeroom Accounting by Chairman W. F. Stevens, Edison Electric Illuminating Co. of Boston.
Adjournment.

ACCOUNTING SECTION—SECOND SESSION.
Wednesday, June 1, 2:15 p. m.

Report (printed) of Committee on Federal Income Tax Procedure by Chairman F. B. Odlum, Electric Bond & Share Co., New York City.
Paper (printed) on "Accounting for Coal" by H. M. Edwards, New York Edison Co.
Report (printed) of Committee on Customers' Records and Billing Methods by Chairman J. D. Jacobus, Detroit Edison Co.
Report of Committee on Credits and Collections by Chairman David Darlington, New York Edison Co.
Adjournment.

ACCOUNTING SECTION—THIRD SESSION.
Thursday, June 2, 2:15 p. m.

Report of Nominating Committee.
Election of Officers and Executive Committee.
Report (printed) of Committee on Bonus Systems by Chairman A. H. S. Cantlin, Pennsylvania Power & Light Co., Allentown, Pa.
Report of Committee on Security Holders' Records by Chairman William S. Kline, Commonwealth Edison Co., Chicago.
Report of Committee on Investment Budget Control by Chairman Harry A. Snow, Detroit Edison Co.
Address on "Accounting Service to Member Companies" by E. J. Fowler, Commonwealth Edison Co., Chicago.
Adjournment.

COMMERCIAL SECTION—FIRST (PARALLEL) SESSIONS.
Tuesday, May 31, 2:15 p. m.

Address by Section Chairman M. S. Seelman, Jr., Brooklyn Edison Co., Inc.
Appointment of Nominating Committee.
Report (printed) of Bureau of Advertising and Publicity Service by Chairman L. D. Gibbs, Edison Electric Illuminating Co. of Boston.
Report (printed) of Division of Adequate Outlets and Co-ordinate Advertising by Chairman P. L. Thomson, Western Electric Co., New York City.
Report (printed) of Division of Illuminating Engineering (Non-technical) by Chairman P. B. Zimmerman, National Lamp Works of General Electric Co., Cleveland.
Report of Division of Motion Picture Films by Chairman M. C. Turpin, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.
Report of Division of National Commodity Advertisers by Chairman Earl E. Whitehorne, 320 Fifth avenue, New York City.
Report (Printed) of Division of Newspaper Advertising Campaigns by Chairman Norman Maul, The New York Edison Co.
Report (Printed) of Division of News Syndicate and Magazine Writers by Chairman Frank B. Rae, Jr., Cleveland.
Report (Printed) of Division of Publications by Chairman Cyril Nast, New York Edison Co.
Report (Printed) of Committee on Education by Chairman Fred R. Jenkins, Commonwealth Edison Co., Chicago.
Report (Printed) of Committee on Electrical Salesman's Handbook by Chairman George H. Stickney, Edison Lamp Works of General Electric Co., Harrison, N. J.
Adjournment.

Tuesday, May 31, 2:30 p. m.

Report (printed) of Power Sales Bureau by Chairman H. H. Holding, Public Service Electric Co., Newark, N. J.
Report (printed) of Division of Economics of the Use of Central-Station Electric Power by Chairman J. W. Meyer, The Philadelphia Electric Co.
Report (printed) of Division of Industrial Electric Heating by Chairman N. T. Wilcox, Mississippi River Power Co., Keokuk, Ia.
Report (printed) of Division of Electric Arc Steel

Furnaces by Chairman Joseph McKinley, Duquesne Light Co., Pittsburgh.
Report (printed) of General Power Division by Chairman George H. Jones, Commonwealth Edison Co., Chicago.
Address on "The Power of Transportation" by E. S. Mansfield, Edison Electric Illuminating Co. of Boston.
Adjournment.

COMMERCIAL SECTION—SECOND (PARALLEL) SESSIONS.

Wednesday, June 1, 2:00 p. m.

Report (printed) of Merchandising Sales Bureau by Chairman Dorsey R. Smith, Consolidated Gas, Electric Light & Power Co., Baltimore.
Report (printed) of Electrical Merchandise Division by Chairman C. E. Greenwood, Edison Electric Illuminating Co. of Boston.
Report (printed) of Division of Electric Shop Management by Chairman Thomas Berger, Philadelphia Electric Co., Philadelphia.
Report (printed) of Division of Standardizing and Testing by Chairman R. S. Hale, Edison Electric Illuminating Co. of Boston.
Report (printed) of Electric Range Division by Chairman C. O. Dunten, Central Illinois Public Service Co., Springfield, Ill.
Adjournment.

Wednesday, June 1, 2:15 p. m.

Report of Electric Vehicle Bureau by Chairman E. S. Mansfield, Edison Electric Illuminating Co. of Boston.
Reports (several committees, details to be supplied).
Paper (general subject—Economy of Electrics. Speaker to be selected).
Paper (general subject—Electric Vehicle Problems. Speaker to be selected).
Discussion.
Report (printed) of Committee on Compensation of Salesmen by Chairman L. R. Wallis, Edison Electric Illuminating Co. of Boston.
Address on "Capitalizing an Opportunity" by W. L. Goodwin, assistant to president, Society for Electrical Development.
Report (printed) of Committee on Commercial Service and Relations with Customers by Chairman L. A. Coleman, United Electric Light & Power Co., New York City.
Adjournment.

COMMERCIAL SECTION—THIRD SESSION.

Thursday, June 2, 2:15 p. m.

Report of Nominating Committee.
Election of Officers and Executive Committee.
Report (printed) of Lighting Sales Bureau by Chairman Oliver R. Hogue, Commonwealth Edison Co., Chicago.
Report (printed) of Committee on Educational Exhibits by Chairman Clarence L. Law, New York Edison Co.
Report (printed) of Division of Residence Lighting by Chairman M. Luckiesh, National Lamp Works of General Electric Co., Cleveland.
Report (printed) of Division of Street and Highway Lighting by Chairman W. D'A. Ryan, General Electric Co., Schenectady, N. Y.
Report (printed) of Industrial Lighting Division by Chairman G. Bertram Regar, Philadelphia Electric Co.
Report (printed) of Division of Lighting of Large Buildings by Chairman F. A. Gallagher, Narragansett Electric Lighting Co., Providence, R. I.
Report (printed) of Division of Commercial Aspects of Lamp Equipment by Chairman Earl A. Anderson, National Lamp Works of General Electric Co., Cleveland.
Report (printed) of Division of Sign, Display and Billboard Lighting by Chairman H. I. Markham, Federal Sign System (Electric), Chicago.
Report (printed) of Store Lighting Division by Chairman James J. Kirk, Commonwealth Edison Co., Chicago.
Adjournment.

PUBLIC RELATIONS SECTION SESSION.

Wednesday, June 1, 2:30 p. m.

Address by Section Chairman J. E. Davidson of Public Relations National Section, Nebraska Power Co., Omaha.
Appointment of Nominating Committee.
Report (printed) of Committee on Manufacturers' Advertising by Chairman P. L. Thomson, Western Electric Co., New York City.
Report of Committee on Public Utility Information by Chairman John F. Gilchrist, Commonwealth Edison Co., Chicago.
Report of Committee on Public Utility Taxation and Uniformity of Regulatory Laws by Chairman W. W. Freeman, Union Gas & Electric Co., Cincinnati.
Report of Committee on Relations with Bankers by Chairman M. S. Sloan, Brooklyn Edison Co.
Announcements.
Report of Committee on Relations with Regulatory Bodies by Chairman R. H. Ballard, Southern California Edison Co., Los Angeles.
Report of Committee on Up-Building the Industry by Chairman F. R. Coates, Toledo Railways & Light Co., Toledo, O.
Report of Nominating Committee.
Election of Officers and Executive Committee.
Adjournment.

TECHNICAL SECTION—FIRST (PARALLEL) SESSIONS.

Tuesday, May 31, 2:15 p. m.

Address by Section Chairman I. E. Moultrop, Edison Electric Illuminating Co. of Boston.
Appointment of Nominating Committee.
Report (printed) of Committee on Electrical Apparatus by Chairman R. F. Schuchardt, Commonwealth Edison Co., Chicago.
Report of Committee on Safety Rules by Chairman Thomas Sproule, Public Service Electric Co., Newark, N. J.
Adjournment.

Tuesday, May 31, 4:00 p. m.

Report (printed) of Meter Committee by Chairman W. L. Wadsworth, Minneapolis General Electric Co., Minneapolis, Minn.
Adjournment.

TECHNICAL SECTION—SECOND SESSION.

Wednesday, June 1, 2:15 p. m.

Report of Nominating Committee.
Election of Officers and Executive Committee.
Report (printed) of Committee on Overhead Systems by Chairman W. K. Vanderpoel, Public Service Electric Co., Newark, N. J.
Report (printed) of Committee on Inductive Interference by Chairman A. E. Silver, Electric Bond & Share Co., New York.
Adjournment.

TECHNICAL SECTION—THIRD (PARALLEL) SESSIONS.

Thursday, June 2, 2:30 p. m.

Report (printed) of Committee on Hydraulic Power by Chairman Markham Cheever, Utah Power & Light Co., Salt Lake City.
Report (printed) of Committee on Prime Movers by Chairman N. A. Carle, Public Service Electric Co., Newark, N. J.
Adjournment.

Thursday, June 2, 2:30 p. m.

Report (printed) of Committee on Underground Systems by Chairman F. E. Ricketts, Consolidated Gas, Electric Light & Power Co., Baltimore.
Adjournment.

PUBLIC POLICY COMMITTEE SESSION.

Thursday, June 2, 8:30 p. m.

Report of Public Policy Committee by Chairman Sidney Z. Mitchell, Electric Bond & Share Co., New York City.
Address (speaker of national prominence invited).
Adjournment.

SPECIAL MEETINGS.

National Executive Committee—Luncheon at 1:00 p. m., May 31.
Executive Committee meeting of Accounting Section at 8:30 p. m., May 30.
Executive Committee meeting of Commercial Section at 8:30 p. m., May 30.
Executive Committee meeting of Public Relations Section at 8:30 p. m., May 30.
Executive Committee meeting of Technical Section at 8:30 p. m., May 30.
Electric Vehicle Bureau—Luncheon at 12 m., June 2.
Public Policy Committee—Luncheon at 1 p. m., June 2.

EDITORIAL COMMENT

Some Features of Railway Electrification

Wm. J. Keary, in a communication to the New York *Herald,* replies to criticisms recently made by P. W. Reynolds, in relation to the electrification of railroads, and brings out some very good points. Mr. Keary says:

"It is quite true that it is the financial aspect of the question that will exert the greatest influence on the railroad corporation's decision to electrify. The great advantages claimed for electrification are, that it will considerably reduce fuel costs and increase transportation capacity, and that, further, it will provide an outlet for the profitable utilization of the power that can be derived from developing our water resources.

"It is admitted that as our country expands we will need greater transit capacity than we now possess. This can be acquired by opening new rights of way, doing new tunnelling, laying additional trackage and so forth, but if it can be achieved equally well by electrifying the roads, is not the latter the logical method, not only because it is cheaper but also because it carries with it additional benefits?

"Railroad executives will find justification for electrification in the fuel saving and additional business it will permit them to handle. That electrification pays is demonstrated by the experience of the Butte, Anaconda & Pacific, which in the first year of electrical operation showed a saving of $257,889 on an outlay of $1,201,000 for cost of electrification. While no figures are available for the C., M. & St. P., it has been asserted that the economies effected more than justify the capital expenditures.

"Granting that there may be a few steam locomotives in operation with a maximum capacity of over 5000 hp., these fall short of the capabilities of the electrical locomotive. The Pennsylvania railroad has an electrical locomotive with a rating of 7000 hp.; and it is within the range of possibilities to apply even double this horsepower to a train provided the roadbed and equipment prove suitable.

"The length of time during which the electric locomotive can maintain its maximum tractive effort is necessarily limited, but even relatively speaking it is superior in this respect to the steam locomotive. Actual experiments on the C., M. & St. P. have shown that the electrical locomotive can accomplish twice the distance of the steam locomotive without going to the shop for repairs and inspection. On one division of its line 220 mi. long, one-half of the roundhouses were discontinued on the introduction of electrical operation.

"There is nothing unfair in comparing the relative merits of both types of locomotives. True, the steam locomotive is self-contained, but it has to carry its fuel with it at a sacrifice of other freight that would yield revenue, and is wasteful in this respect as well as in its consumption of fuel when no useful work is being done.

"Regenerative braking was not claimed as one of the outstanding advantages of electrification but is regarded as merely incidental. The facts that it minimizes the dangers on perilous mountain grades, saves the braking equipment from the hardship that its application on steep grades entails and makes the descent pleasanter for passengers are sufficient to deem it worthy of note

"In speaking of water-power capacity it is pointed out that all of it could not be utilized because of prohibitive engineering expenses, but undoubtedly the major portion of it can be profitably harnessed. If it could be all put to work it would of itself furnish all the power necessary to move our trains, but because this is impracticable, water and coal must each supplement the other. Not in the unscientific manner in which they are now used, but in an efficient way, through concentration at central points and transmission by great interconnected systems.

"Mr. Reynolds is quite correct in his contention that the railroads would find it cheaper to purchase their power than to generate it themselves. The ideal condition would be for the railways to construct the necessary equipment for the reception and application of the power along their roadbeds, and have the power furnished at certain points by independent public utility corporations.

"This arrangement would serve the additional purpose of distributing the burden of providing new capital between the public utilities and the railroads and thus considerably facilitate the necessary financing. Power for the C., M. & St. P. is not manufactured directly by the company but is supplied by the Montana Power Co., which derives most of its energy from the harnessing of the Missouri river.

"It is admitted that at the present moment only a few of the strongest railroads could undertake an electrification program. As normal conditions are restored, however, and the railroads demonstrate their earning power under fair treatment

their credit will be re-established and they will be in a position to carry out constructive developments. Railroad electrification will receive an impetus from the development of our water resources and the perfection of interlocking power systems. And the determining consideration in the minds of railroad executives will be not only its efficiency but its cheapness. Certainly electrification cannot or will not be accomplished in a year or two, but like most other great developments it will come gradually but surely."

Railway Electrification in Switzerland

At the present time considerable work is being done in Switzerland in railway electrification, not only in connection with new projects, but also in completing work which has been partly suspended during the war. One of the first programs for electrification had reference to the Gothard line, and since the first sector—from Erstfeld to Bellinzona—is now nearly complete, a few particulars concerning this work should be of general interest.

Two hydroelectric power stations will ultimately be used to supply the energy necessary to operate this line, but since the one at Ritom is nearly completed while the other at d'Amsteg is only in the early stages of construction the former only will be referred to at this time. The water is obtained from lake Ritom by an intake constructed at a level of 100 ft. below the natural level of the lake. This natural level has been raised 23 ft. by means of a dam, thus producing a total available storage of 920,000,000 cu. ft. of water.

The average annual flow is 35 cu. ft. per sec., which, with an available head of 2600 ft., gives about 8500 hp. at the turbines on the basis of 24 hr. day. A tunnel 6.5 ft. by 5.25 ft. by 3450 ft. long, with a gradient of 7%, leads the water into the pressure pipes consisting of two parallel pipes, each tapering from 3.6 ft. to 3 ft. At the lower end each pipe is again subdivided because of the high pressure into two branches, each tapering from 2.8 ft. to 2.13 ft. Ultimately there will be a third pipe leading from the lake so that there will be a total of six pipes entering the generating station. The length of each pressure pipe is 4600 ft.

The present equipment in the power house consists of four groups of machines, but a total of six sets is contemplated. Each turbine has a capacity of about 12,000 hp. and is coupled to a single-phase alternator running at 333.5 r.p.m. and wound for terminal pressures of 7500 and 15,000 volts.

Transmission to the substations is at 60,000 volts. There will ultimately be five substations, three of which are already nearly completed. The overhead trolley line appears to present no special features differing from standard practice in this country. The locomotives receive energy from the line at 15,000 volts and 16.66 cycles per sec. Those for the express trains are capable of drawing a load of 300 metric tons at a speed of 31 mi. per hr. up an incline with a grade of 2.6% without the aid of a second locomotive which is occasionally used on certain sections of the line. Transformers on the locomotives reduce the pressure from 15,000 volts to 585 volts at the terminals of the motors. These locomotives can attain a speed of 46 mi. per hr. They have a total weight of 112 tons, and the diameter of the driving wheels is 5 ft. For freight trains another type of locomotive is used with a maximum speed of 41 mi. per hr., a total weight of 128 tons, and driving wheels 4.4 ft. diam.

Water Power and Heat Accumulation

Fuel problems in Switzerland have to be regarded from a different point of view from that usual in this country. Here coal is (or was) abundant and cheap, there it is scanty and expensive. On the other hand, in Switzerland there is plenty of water power and it is not, therefore, surprising that the possibilities of using electric heating for operations which we still consider outside its range, are there being seriously considered. Some of these depend on the accumulation of heat by steam or hot water, but in a paper read recently before the Swiss Society of Engineers M. Paul Beuttner described an electrical method of effecting the same purpose. He uses a stove which is electrically heated for 15 hrs. a day, that is continuously except during the lighting period. This allows meals to be cooked at any time in spite of the fact that the rate of current consumption is small. For instance, in a particular test on cooking the meals of a large family it was found that the breakfast consumed 0.87 kw-hr., the midday meal 3 kw-hr., the evening meal 1.95 kw-hr., while 6.50 kw-hr. went in what is described as "losses."

These "losses" apparently go in heating the water for washing up, so that a satisfactory electrical service is obtained with a demand of 0.8 kw., lasting 15 hrs., or at a cost in Zurich of 0.79 francs a day as against 1.25 francs for the same amount of energy used for cooking in the ordinary way. Where a special night rate of 0.03 francs per unit is available the cost is further reduced to 0.45 franc. These stoves, which are heated by rods of silicium carbonate, function equally well with coal or wood and are being largely used in the baking industry. This is evidence that a great deal more might be done than

is being done in this country in the use of high-load factor appliances, proper care being taken to ensure their removal from the circuit during peak load.

Standardization of Industrial Substations

The industrial substation has come to be quite a well-known affair. With certain modifications required to take care of each different central-station company and special conditions to be met with here and there, the industrial substation has assumed certain features of standardization in design and construction. Standardization means, among other things, that the work of designing each installation, building each installation and keeping the necessary spare parts are all much simplified; operating the substations becomes a simple matter since knowing the layout of one is to know the layout of all, with some secondary modification in individual cases. Basically and fundamentally, however, the substations are the same, and whether it be a machine shop, an ice plant or an electric furnace that is to be served, everything connected with it is simplified.

Standardization tends, perhaps, to dwarf growth, hinder improvement and discourage betterment. If this fact is borne in mind the danger in stopping progress and stifling evolution is largely eliminated, or at least is set aside to such an extent that the benefits of standardization far outweigh the possible disadvantages. The large industrial load is no longer the property of the largest utilities; some of the smaller ones now connecting loads representing quite an appreciable portion of their generating capacity. It is these smaller companies that have not as yet reached the point where they have had sufficient experience with industrial substations on a large scale to permit standardization.

Progress only comes from evolution or improvement from imitation. The smaller companies can do nothing better than to find out what the larger leading companies are doing and then apply this knowledge to their own conditions. In this way many of the smaller utilities can commence where the larger utilities *longer in the game* have left off. This will mean real progress and a very real gain.

Eyestrain and Moving Pictures

A report presented to the London County Council by a joint committee appointed by the Illuminating Engineering Society on the subject of eyestrain in cinema theaters is based upon observations made in a large number of moving-picture theaters in London. The chief objection to placing seats very close to the screen is shown to be the discomfort and eyestrain caused by the necessity of directing the eyes upward at an abnormal angle. The committee recommended that the angle of elevation subtended at the eye of a person seated in the front row by a vertical line dropped from the center of the top edge of the picture shall not exceed 35 deg., the observer's eyes being assumed to be at a height of 3 ft. 6 ins. above the floor level.

With regard to the oblique angle of view, this appears to cause less trouble than a large angle of elevation. It is, however, recommended that the angle between the vertical plane containing the observer's eye and the farther end of the upper edge of the picture and the vertical plane containing the upper edge of the picture shall not be less than 25 deg. Other recommendations have reference to the maximum distance of seats from the screen and also to the avoidance of imperfect films. A point which may well receive attention in this country is the definite statement that no unscreened source of light should be visible to the observer in any seat in the theater when looking toward the picture. The extreme inconvenience and irritation caused by unscreened points of light very close to the line of vision, when looking at the picture, appears to be very frequently overlooked. It is pointed out in the report that the illumination should not be less than 0.025 foot-candles in any part of the theater, and this can readily be accomplished with properly screened lights.

Use of Flexible Cord

One sometimes hears electrical inspectors express the hope that the day may speedily come when the use of flexible cord in electric service will be discontinued. It is probable, however, that such expressions are provoked by difficulties encountered in preventing the improper use of material of this sort oftener than by any desire to prohibit the use of it altogether; for it seems to be very hard if not, indeed, impossible to keep inexperienced persons from using cord in ways that were never intended by the manufacturers and which, moreover, are sometimes anything but safe. For example, circuits are run by nailing it on some surface with metal staples; or, perhaps, cord designed for pendent service is used where only portable cord should be employed. Flexible cord fills a highly useful place in the electrical industry and will doubtless continue to do so for a long time to come, but the improper use of it should be discouraged in every possible way. Electricians and retail dealers in wiring materials can do more toward insuring the correct use of cord, it would seem, than can be accomplished even by the inspectors themselves.

THE WEEK'S NEWS

Reports of Important Meetings, Developments and Other Happenings of the Electrical Industry and Its Allied Interests

GEOGRAPHIC DIVISION TO DISCUSS OPERATING PROBLEMS.

Annual Meeting of Southwestern Geographic Division, N. E. L. A., to Be Held at Hot Springs National Park, Ark., May 13-14.

Among the main subjects to be discussed at the first annual meeting of the Southwestern Geographic Division of the National Electric Light Association to be held May 13-14, will be "Customer Ownership," "The Economies of Transmission Line and Distributing System Supports," "The Operating Problem of Inductive Interference," and "The Super-Power Central Station." Convention headquarters will be maintained at the Arlington Hotel, Hot Springs National Park, Ark. Arrangements have been made to hold the general sessions on Friday morning, May 13, and the morning and afternoon of May 14. On Friday afternoon there will be meetings of the Accounting, Commercial, Public Relations and Technical Sections.

The entertainment features arranged for the convention are quite elaborate and include a trip to the power station of the Citizens Electric Co., Hot Springs, Ark. The Westinghouse Electric & Manufacturing Co. plans to have on display in the Arlington Hotel its "Better Merchandising" exhibit, and in addition to this the St. Louis Electrical Board of Trade has designed "The Model Store" for the occasion, which will be filled with electrical goods. The program as arranged follows:

May 13, 10 *a. m.*—General Session: Invocation by Dr. J. Ellsworth Coombs; address of welcome by Governor Thomas C. McRae of Arkansas; address of President A. Hardgrave, Middle West Utilities Co., Dallas, Tex.; announcements by S. E. Dillon, general chairman of Convention Committee; introductions conducted by the five vice-presidents of the Southwestern Geographic Division, N. E. L. A.; report of Secretary H. A. Lane, Oklahoma Utilities Association, Oklahoma City, Okla.; report of Treasurer J. B. Walker, Dallas (Tex.) Power & Light Co.; report of the Membership Committee by E. H. Kifer, San Antonio (Tex.) Public Service Co.; appointment of special committees by President Hardgrave; report of the Company Employes Organization Committee by O. A. Jennings, Oklahoma Gas & Electric Co., Oklahoma City, Okla.; address on "Customer Ownership" by C. J. Stubner, Henry L. Doherty & Co., Bartlesville, Okla., and report of the Accident Prevention Committee by W. G. Schmauder, Texas Power & Light Co., Dallas, Tex.

May 13, 2:15 *p. m.*—Accounting Section: Address by Section Chairman J. M. Dickie, Middle West Utilities Co., Dallas, Tex.; paper on and discussion of "Security Holders' Records"; report on and discussion of "A Uniform System of Accounting"; paper on and discussion of "The Bonus System"; transaction of business and adoption of recommendations to be submitted to the Division Executive Committee.

May 13, 2:15 *p. m.*—Commercial Section: Address by Section Chairman W. E. Clement, New Orleans (La.) Railway & Light Co.; paper on "Merchandise Sales" by W. B. McSpadden, City Light & Water Co., Amarillo, Tex.; paper on "Commercial Service and Relations With Customers" by P. C. Tucker, The Pine Bluff (Ark.) Co.; address on "Lighting Sales" by C. W. Barber, Oklahoma Gas & Electric Co., Enid, Okla.; paper on "Electric Vehicles" by F. J. Schwab, New Orleans (La.) Railway & Light Co.; paper on "Power Sales" by R. I. Brown, Little Rock (Ark.) Railway & Electric Co.; paper on "Advertising and Publicity Service" by J. C. Lamb, Baton Rouge (La.) Electric Co.; transaction of business and adoption of recommendations to be submitted to the Division Executive Committee, and illustrated lecture on "Correct Industrial Lighting" by F. J. Schwab, New Orleans (La.) Railway & Light Co.

May 13, 2:15 *p. m.*—Public Relations Section: Address by Section Chairman H. C. Couch, The Pine Bluff (Ark.) Co.; report of the Publicity Committee of the Accident Prevention Committee; address on "Publicity" by H. A. Lane, Oklahoma Utilities Association; report of the Organization Committee of the Accident Prevention Committee; address on "Should the Public Utility Company Advertise?" by George A. Davis, Oklahoma Gas & Electric Co., Oklahoma City, Okla; committee and questionnaire reports; transaction of business and adoption of recommendations to be submitted to the Division Executive Committee.

May 13, 2:15 *p. m.*—Technical Section: Address by Section Chairman J. B. Thomas, Texas Power & Light Co., Dallas, Tex.; papers on "The Application of Diesel Engines to Small Electric Power Stations," "The Economies of Transmission Line and Distributing System Supports," and "The Operating Problem of Inductive Interference"; report of the National Electrical Code Committee; organization meetings of following committees, (1) Overhead and Underground Lines, (2) Meter, (3) Electrical Apparatus, (4) Inductive Interference and (5) Prime Movers; business meeting and adoption of recommendations to be submitted to the Division Executive Committee; subcommittee reports of Accident Prevention Committee: (1) Operating Methods, (2) Devices and Appliances, (3) Apparatus and (4) Fire Prevention.

May 13, 7 *p. m.*—Banquet and Public Policy meeting: Talk by the president; four 5-min. talks, and an address on "The Public's Business" by Martin J. Insull, Chicago, president of the National Electric Light Association.

May 14, 10 *a. m.*—General Session: Address on "Public Policy" by Hamilton Moses, Little Rock, Ark.; report of the Wiring Committee by J. H. Gill, Dallas (Tex.) Power & Light Co.; addresses on "The Kansas Industrial Law" by W. L. Huggins, Court of Industrial Relations, Topeka, Kan., and "The Super-Power Central Station" by J. B. Thomas, Texas Power & Light Co., Dallas, Tex.

May 14, 2 *p. m.*—General Session: Address on "The Needs of the Industry" by J. H. Gill, Dallas (Tex.) Power & Light Co.; report of the Health Promotion Committee; addresses on "The Work of the N. E. L. A." by W. J. Canada, engineering department of the National Electric Light Association, and "Internal Organization" by J. F. Owens, Oklahoma Gas & Electric Co., Oklahoma City, Okla.; reports of committees and election of officers.

PENNSYLVANIA DEALERS TO MEET IN BUFFALO.

At a recent session in Philadelphia, the Executive Committee of the Pennsylvania State Association of Electrical Contractors and Dealers completed arrangements for holding the semiannual meeting of the Association at the Lafayette Hotel, Buffalo, N. Y., July 19, in connection with the National Convention which immediately follows. As the sessions of both the State and National Associations will be of unusual interest a large

attendance is expected, and a special room at the Lafayette Hotel has been provided as headquarters for the Pennsylvania State representation through the entire period of the convention. The New York State Association will hold a meeting on the same date and place, and a joint acquaintanceship session will be arranged if possible.

WISCONSIN DEALERS' ASSOCIATION MAKES PROGRESS.

A revision of the schedule of dues, which were lowered approximately 50%, was among the more important business transacted at the quarterly meeting of the Wisconsin State Association of Electrical Contractors and Dealers held at Appleton, Wis., last month. The Association voted to secure the services of L. W. Davis, special representative of the National Association, to assist the Wisconsin organization in a drive for new members. Mr. Davis gave a talk on the activities of the National Association, as a result of which a number of applications for membership were received.

It was decided to hold the summer outing July 9-11, which will consist of an automobile trip to the chain of lakes located near Waupaca, Wis., where headquarters will be maintained. A steamer will be secured for a trip up the Wolf river for the second day, and it is planned to hold a business meeting July 11 at the lakes.

SOUTHWESTERN ASSOCIATION WILL MEET AT GALVESTON.

Inductive Interference and Financing of Local Utilities Among Subjects to Be Discussed at Annual Convention.

"The Public's Business" and "The Utility Association as a Permanently Profitable Investment" will be among the important subjects discussed at the 17th annual convention of the Southwestern Electrical and Gas Association, to be held at the Hotel Galvez, Galveston, Tex., May 18-21. The entertainment features will consist of a vaudeville show on Wednesday evening, a dance on Thursday evening, and the annual banquet on Friday evening. The business program for the meeting follows:

May 18—Registration and meeting of various committees in the morning. The opening session will be held in the afternoon and will be devoted to the president's address; report of the secretary on Association activities; appointment of various convention committees, etc., and an address by an invited speaker on some topic of interest and value to the utility business at large.

May 19—Light and Power Session in the morning, at which papers, reports and discussions will be submitted on technical and operative matters pertaining to this section. A parallel session of the Street and Interurban Railway Section will be held at the same time, when "problems of the minute" in electric transportation will be stated and discussed. On Thursday afternoon the first General Session will be held, at which time the following addresses will be presented: "The Public's Business" by Martin J. Insull, president of the National Electric Light Association; "The Utility Association as a Permanently Profitable Investment" by J. H. Gill, and "The Latest Developments in Texas Lignite" by Dr. E. P. Schoch.

May 20—A joint session of the technical and commercial departments of the Light and Power Section will be held in the morning, and the Street and Interurban Railway Section will also meet. In the afternoon the second General Session will convene, when addresses will be given on "State Utility Commissions" by W. G. Busby, chairman of the Missouri Public Service Commission; "Inductive Interference" by W. J. Canada, engineering department of the National Electric Light Association; two addresses on "Home Town Financing of Local Utilities" by those who have had recent practical experience in this matter, and an address from the banking side on the same subject by a Texas banker.

May 21—The business and final sessions will be held in the morning, when all unfinished business will be completed and the reports of the treasurer, secretary and various committees will be received and acted upon.

DEVELOPMENT PROJECTS OUTLINED IN ANNUAL REPORT.

Southern California Edison Co. Makes Satisfactory Progress in Its Co-operative Educational Movement—Construction Work Planned.

In the annual report of the Southern California Edison Co. for the year 1920, the statement is made that the educational movement to cement friendly relations within the electrical industry and tone up the various points of contact with the public made satisfactory progress last year. Power-company officers and employes, manufacturers, jobbers, electrical contractors and dealers are all working toward the same goal, namely, to avoid differences and misunderstandings and to harmonize the intercourse between individuals and the concerns which they represent. The spirit of service is prevalent throughout all branches of the industry, with the result that the public good-will is being strengthened and increased. The co-operative educational work will continue during 1921 on a larger scale than heretofore and substantial benefits are expected to accrue to all concerned.

Regarding waterpower development and construction projects, which were outlined on page 374 of the March 5 issue of ELECTRICAL REVIEW, the report states:

Active progress was made during 1920 on the waterpower development program, which has ultimate potential possibilities aggregating nearly 4,000,000 hp. of waterpower located on the San Joaquin, Kern and Colorado rivers. Construction work on the Kern river No. 3 plant, which will have a total installed capacity of 40,000 hp., progressed satisfactorily during 1920. The first 20,000-hp. generator, also the second unit, will be put into operation this spring. This plant will have an average annual production of 180,000,000 kw-hrs.

Construction work on the Big Creek developments on the San Joaquin river were concentrated on the following projects: (a) The third 22,000-hp. unit at Big Creek No. 2 plant, (b) diversion of Shaver lake for use through Big Creek Power House No. 2, (c) the first 20,000-hp. unit in the new Big Creek No. 8 plant, and (d) Florence lake tunnel. The third generating unit in Big Creek Power House No. 2 was placed in operation Jan. 27, 1921. It adds 22,000 hp. to the system peak capacity, and 20,000,000 kw-hrs. annually to waterpower production.

The Shaver lake diversion will make the water of Stevenson creek available for use through Big Creek Power House No. 2. The tunnel is being constructed only for present needs, with a capacity of 400 cu. ft. per sec. It will later be increased to 1500 cu. ft. per sec. for the purpose of handling Shaver lake water after the enlargement of Shaver lake to a capacity of 135,000 acre ft.

The construction of Big Creek Power House No. 8 was started in 1920 as a quick development to relieve power shortage. Its initial installation will be a single generating unit rated at 30,000 hp., having an average annual output of 106,000,000 kw-hrs. The ultimate development of this plant will have an installed capacity

of 180,000 hp. The installation of the first unit is scheduled for completion by August, 1921.

Active construction was started on Florence lake tunnel in 1920 with the intention of completing it in time to utilize the spring run-off of 1925. This tunnel, 14 by 14 ft. in cross section and 13.5 mi. in length, capable of discharging 1000 cu. ft. of water per sec., will be used to divert the south fork of the San Joaquin river, including Mono and Bear creeks, through Kaiser Ridge and discharge it into Huntington lake. The drainage area naturally flowing into Huntington lake amounts to 79 sq. mi. The drainage area of the south fork of the San Joaquin river and tributaries which will be diverted into Huntington lake through Florence lake tunnel is 315 sq. mi. This diversion will therefore multiply the potential power possibilities of the water coming through Huntington lake by approximately five times its present value. When the water made available through Florence lake is completely utilized through its entire fall of 6000 ft., it will be capable of generating 1,750,000,000 kw-hrs. per year, or about 400,000 hp. at commercial use.

The completion of Florence Lake tunnel will make it possible to reduce steam production to a minimum and will provide easy increments to waterpower production to take care of growth of load by installing additional generating units in existing powerhouses and in those planned for the future.

TO TELL STORY OF ELECTRICITY AT CHICAGO SHOW.

Exhibits Planned for Pageant of Progress Exposition to Demonstrate Development and Use of Electricity.

Electricity will be shown in all its vast variety of applications at the Pageant of Progress Exposition on Chicago's mammoth Municipal Pier, July 30-August 14, during which visitors are promised a visualization of the complete history of the development and use of electricity. There have been numerous electrical shows at various times but the management promises something more thoroughly representative of the industry than has ever before been attempted. Nor will the entertainment features be overlooked, as the exhibits are being planned to tell the story of electricity in the most picturesque manner.

One subsection consisting of a series of six booths will be devoted to the miniature representative of electric transportation in its entirety. On the floor space of this section there will be full-sized electric vehicles, including a large truck, a coupe, an industrial truck of the type used in factories, a tractor, a mining locomotive and probably a street car. Directly above these exhibits will be a panoramic painting, 140 ft. in length, showing some scenes along the right-of-way of the Elevated and North Shore Electric roads, between Chicago and Milwaukee, with a tiny model train in constant operation along the pictured track. Above this painting with its miniature train will be a second painting. This will have scenes taken from along the right-of-way of one of the transcontinental railroads which has been electrified in part. This painting, which will also be 140 ft. in length, will show miniature powerhouses, water-falls and tunnels, and there will be several model electric trains which run along this route and through the tunnels, operating continuously.

The story of lighting will also be told in an interesting fashion and several exhibits will be shown to illustrate the remarkable changes which take place due to lighting effects. These exhibits have been developed as a result of many interesting experiments in the laboratories. For example, in the picture of a woman in certain lights she appears in a certain costume; by simply changing the lights the entire costume is apparently changed.

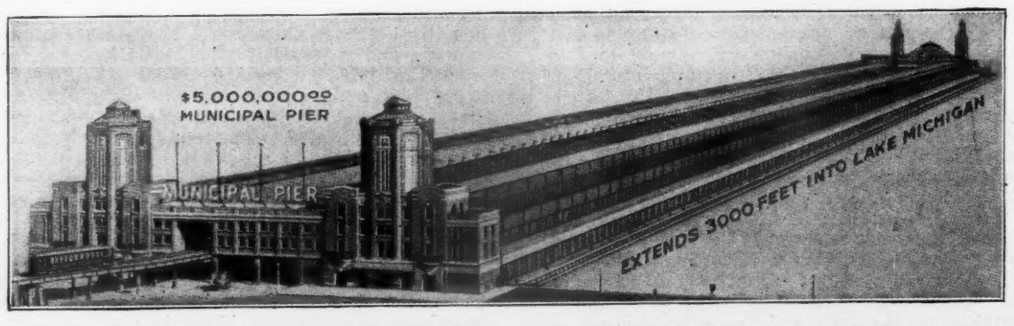
There will be much in this section to mystify the beholder but, before he has passed out of this section, the mystery of the application of electricity will be dispelled by showing how absolutely simple all manner of devices are by having the parts made and then assembled where the people can see it. These are just a few of the features which will be shown at the Pageant of Progress Exposition. The exhibit will be so entertaining and all-inclusive that it will take a whole day to see just the electrical exhibit alone in its entirety.

UTILITIES ASSOCIATION DISCUSSES FRANCHISE PROBLEMS.

Valuation and Rate of Return of Utilities Among Topics Touched Upon by Missouri Association of Public Utilities.

Every phase of the operation of public utilities was discussed by the Missouri Association of Public Utilities during its 15th annual convention held in Kansas City, Mo. The most important topics touched upon were in connection with methods of valuation and rate of return of utilities, and the legal aspects of determinate and indeterminate franchises.

"Public service, and not petty politics nor class discriminations, should govern the usage of public highways and streets," said J. W. Dana, attorney of the Kansas City Gas Co., in talking on the subject of "The Indeterminate Franchise," which,



Municipal Pier, Chicago, Where Pageant of Progress Exposition Will Be Held.

he continued, "is nothing more nor less than the normal right to use public highways in a legitimate manner in the carrying on of a legitimate business."

In his address on "Methods of Valuation and Rate of Return of Public Utilities," R. A. Brown, attorney for the St. Joseph Railway, Light, Heat & Power Co., presented a review of court decisions and an argument for the present-day cost basis. H. H. Kuhn, engineer of the Kansas City Power & Light Co., in his paper on "Concentration of Generating Equipment at Centers of Economical Production and Transmission," pointed out the possibility of a superpower district including Kansas, Missouri and Arkansas. Other speakers were E. J. McCaustland, dean and director of the School of Engineering, University of Missouri, who spoke on the subject of "The Relation of the College to the Industry"; N. T. Wilcox, Mississippi River Power Co., Keokuk, Ia., who submitted a paper on "Transmission Line Cost and Development and Determining Rates and Minimum Charges," and Lynton T. Block, St. Louis, who presented a paper on "Participating Insurance—What It Is and What It Does."

The election of officers resulted as follows: President, Hermann Spoehrer, secretary of the Union Electric Light & Power Co., St. Louis; first vice-president, E. R. Locke, Mexico, Mo.; second vice-president, E. C. Deal, Springfield, Mo.; third vice-president, H. C. Blackwell, Kansas City, Mo., and secretary-treasurer, F. D. Beardslee, 315 North 12th street, St. Louis. The executive committee consists of L. P. Andrews, Sedalia, Mo.; H. Wurdack, St. Louis; J. D. Von Maur, St. Louis; L. B. Landmann, Jefferson City, Mo., and E. D. Payne, St. Louis.

CENTRAL-STATION COMPANIES WIN RATE DECISION.

According to advices from New York City, the United Electric Light & Power Co. and the New York Edison Co. have obtained a reversal of Judge Cohalan's order of March 27, in which he restrains them from putting into effect increased rates for electric lighting service previously filed with the Public Service Commission. In the opinion of the Appellate Division, which was written by Justice Greenbaum, it was held that the court had no authority to grant relief by the way of injunction proceedings. The opinion holds that the power to increase or decrease rates lies wholly within the jurisdiction of the Public Service Commission. It is probable that the case will be taken to the Court of Appeals by the city.

CABLE COMPANY'S ACTIVITIES IN SOUTHERN HEMISPHERE.

Cable landings have been made by the All America Cables, Inc., New York City, at Lima, Peru; Santa Elena, Ecuador; Guantanamo, Cuba; San Juan del Sur, Nicaragua; Esmeraldes, Ecuador, and Buenos Aires, Argentina. Modern reinforced concrete cable stations are to be built at four of these cities, while plans also are being made for staff quarters, dormitories and recreation buildings. Construction work is already under way at Lima, Peru, and will commence at the other stations with the completion of the plans and specifications. Lockwood, Greene & Co., engineers of Boston and New York City, are in charge of this work.

DISCUSS POWER-FACTOR PROBLEMS AT A. I. E. E. MEETING.

Power-factor problems were discussed at the meeting of the Indianapolis-Lafayette Section, American Institute of Electrical Engineers, held April 29 in Indianapolis, Ind. Addresses were given on "The Effects of Low Power Factor upon the Distribution of Electrical Energy and Their Relation to Rate Schedules," by Prof. C. Francis Harding, head of the School of Electrical Engineering, Purdue University, Lafayette, Ind., and "The Determination of Power Factors in Polyphase Circuits" by Prof. D. D. Ewing, professor of electric railway engineering, Purdue University.

FRANKLIN INSTITUTE TO DISCUSS ELECTRIC TRACTION.

The Franklin Institute of the State of Pennsylvania will meet May 18, at which time a review of electric traction will be given by Frank J. Sprague, and a paper by Charles Fabry, D. Sc., on "Studies in the Field of Light Radiation" will be read by Joseph S. Ames, Ph. D., LL. D., The Johns Hopkins University, Baltimore, Md. There will also be presentations of a certificate of honorary membership to Gen. John J. Pershing, general of the armies of the United States; the Franklin Medal and certificate of honorary membership to the French ambassador, M. Jusserand, on behalf of his government for Prof. Charles Fabry, the University of Paris, France, and the Franklin medal and certificate of honorary membership to Frank J. Sprague, New York City.

S. E. D. TO MEET NEXT WEEK.

The annual meeting of the Society for Electrical Development will be held at the offices of the Society, 522 Fifth avenue, New York City, May 10. There will be a meeting of the Executive Committee May 9, and the Board of Directors will meet immediately after the annual meeting of the Society.

NEW YORK COMMISSION PERSONNEL.

The following is the personnel of the New York Public Service Commission recently appointed by Governor Miller: William A. Pendergast, New York City, chairman; William R. Pooley, Buffalo; Charles Van Voorhis, Rochester; Oliver C. Semple, New York City, and Charles H. Blakeslee, Binghamton.

RADIO MANUFACTURERS TO ELECT OFFICERS.

Announcement is made from the office of Charles E. Dustin, general secretary of the Associated Manufacturers of Electrical Supplies, that a meeting to organize and elect officers for the recently authorized section of radio manufactur-

ers will be held at the Association headquarters, 30 East 42d street, New York City, May 11, at 11 a. m., and about 35 large and small manufacturers of radio products are expected to be represented. The movement has met with universal support and those interested in the industry anticipate most beneficial results and a general stabilization of the trade.

AUTOMATIC TELEPHONE EQUIPMENT FOR JAPAN.

It is reported that the Kwantung government—the Japanese administration in Manchuria—has placed an order for an automatic telephone system of the 10,000-line type for the city of Dalny, the great companion port to Port Arthur, on the southern extremity of Manchuria. The initial installation calls for 5000 lines. Dalny—or Darian, as it is also called—is one of the most important commercial points in the Far East, being the principal port for southeastern Siberia. This territory was ceded to Japan after the Russo-Japanese war and has since been greatly developed and equipped with numerous public works, such as docks and warehouses.

One of the principal considerations that led to the decision to install automatic equipment in Dalny is the great diversity of language found there, which seriously interferes with the efficient operation of the manual system. The same condition prevails in the city of Harbin, 500 mi. north of Dalny, where the administration of the Chinese Eastern Railroad has installed a similar equipment. The exchange at Dalny will be one of the largest and most modern telephone systems in the Far East. The automatic system is also operating in the city of Manila, while the municipal council at Shanghai has on order a private exchange system of 400 lines capacity.

These pioneer installations are expected to be the forerunners of numerous similar exchanges, for experience has proved that they meet the requirements of such cosmopolitan centers where all races and tongues mingle and transact business, not in the traditional fashion of the old East, but along lines not far different from those followed in European and American centers today.

TRAINLOAD OF COAL BURNED EACH DAY BY ONE COMPANY.

S. B. Cushing, statistician for the Public Service Co. of Northern Illinois, reports that when the records for the year, 1920, were compiled it was found the company's electrical output was at the rate of a little over 1,000,000 kw-hrs. per day. This is about 100 times the output of the North Shore Electric Co. in 1904. During the year 459,832 tons of coal were burned in the electrical stations. This quantity represents 10,000 cars or one train of 27 cars each day. Notwithstanding, as said, the output was 100 times greater than that of the North Shore Electric Co. 18 years ago, the coal consumption in 1920 was less than 25 times more. This result was due to the efficiency of modern methods and apparatus. If the economy thus made possible had not been obtained the electrical stations in 1920 would have required four trains of coal of 32 cars each every day.

COMING CONVENTIONS.

Society for Electrical Development. Annual meeting, New York City headquarters, 522 Fifth avenue, May 10. General manager, J. M. Wakeman, New York City.

Arkansas Public Utilities Association. Annual convention, Hot Springs, Ark., May 11-12. Chairman of the convention committee, S. E. Dillon, Hot Springs, Ark.

Southwestern Geographic Division of the National Electric Light Association. Annual convention, Hot Springs, Ark., May 13-14. Secretary, H. A. Lane, Oklahoma City, Okla.

American Washing Machine Manufacturers' Association. Meeting at Sherman Hotel, Chicago, May 18-19. Secretary, Enoch B. Seitz, Otis building, Chicago.

Southwestern Electrical and Gas Association. Annual convention, Galveston, Tex., May 18-21. Headquarters, Hotel Galvez. Secretary, H. S. Cooper, 403 Slaughter building, Dallas, Tex.

National Electrical Credit Association. Annual meeting, Richmond, Va., May 19-20. Headquarters, Hotel Jefferson. Secretary, Frederic P. Vose, Marquette building, Chicago.

American Institute of Electrical Engineers. Annual meeting, Engineering Societies building, New York City, May 20. Secretary, F. L. Hutchinson, 33 West 39th street, New York City.

American Society of Mechanical Engineers. Spring meeting, Chicago, May 23-26. Headquarters, Congress Hotel. Assistant secretary, C. E. Davies, 29 West 39th street, New York City.

International Railway Fuel Association. Annual convention, Chicago, May 24-26. Headquarters, Hotel Sherman. Secretary, J. G. Crawford, 702 East 51st street, Chicago.

Electrical Supply Jobbers' Association. Thirteenth annual meeting, Hot Springs, Va., May 25-27. Headquarters, The Homestead. General secretary, Franklin Overbagh, 411 South Clinton street, Chicago.

Pacific Coast Geographic Division of the National Electric Light Association. Annual convention, Del Monte, Cal., May 25-27. Headquarters, Hotel Del Monte. Secretary, L. H. Newbert, 445 Sutter street, San Francisco.

National Electrical Light Association. Annual convention, Chicago, May 31-June 3. Headquarters, Drake Hotel. Executive manager, M. H. Aylesworth, 29 West 39th street, New York City.

New York State Association, National Association of Stationary Engineers. Annual convention, New York City, June 9-11. Headquarters, Hotel McAlpin, 34th street and Broadway. Secretary, E. Davies, 1379 St. Johns place, Brooklyn, N. Y.

National Fire Protection Association. Annual convention, San Francisco, June 14-16. Secretary, Franklin H. Wentworth, 87 Milk street, Boston.

Tri-State Water and Light Association. Annual convention, Asheville, N. C., June 15-16. Secretary, W. F. Steiglitz, Columbia, S. C.

Canadian Electrical Association. Annual convention, Quebec City, June 15-17. Secretary, Eugene Vinet, Power building, Montreal, Que.

American Society for Testing Materials. Annual convention, Asbury Park, N. J., June 20-24. Headquarters, New Monterey Hotel. Secretary, C. L. Warwick, 1315 Spruce street, Philadelphia.

American Institute of Electrical Engineers. Annual convention jointly with the Pacific Coast convention, Salt Lake City, Utah, June 20-25. Secretary, F. L. Hutchinson, 33 West 39th street, New York City.

National Association of Electrical Contractors and Dealers. Anniversary convention, Buffalo, N. Y., July 18-23. Headquarters, Lafayette Hotel. Secretary, W. H. Morton, 110 West 40th street, New York City.

Pennsylvania State Association of Electrical Contractors and Dealers. Semi-annual meeting, Buffalo, N. Y., July 19. Headquarters, Lafayette Hotel. Secretary, M. G. Sellers, 1518 Sansom street, Philadelphia.

APPLIANCES and DEVELOPMENTS

New, Improved or Interesting Electrical and Mechanical Apparatus and Devices, and Applications of Equipment and Methods in Practice

Fractional-Horse-Power Motors for Many Services.

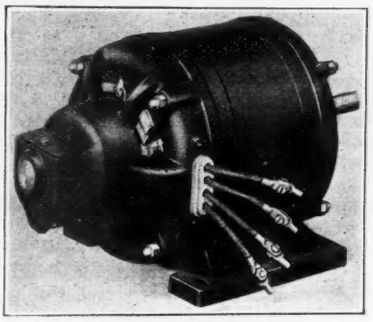
The Allis-Chalmers Manufacturing Co., Milwaukee, is putting on the market a new line of single-phase fractional-horse-power induction motors suitable for domestic and commercial purposes of all kinds. While the line has not been quite fully completed, it is expected that all the motors contemplated will be ready within the course of a few months. As the requirements are varied and numerous two distinct types of machines—repulsion and split-phase—have been developed. They will be available for 110 and 220-volt, 60-cycle, single-phase circuits in the following sizes and speeds: Repulsion type motors with oil-ring bearings in sizes of 1/6, ¼, ½, ¾, and 1 hp., all running at a speed of 1800 r. p. m., and split-phase motors with wick-oiled bearings in 1/6 and ¼ hp. sizes running at 1800 r. p. m.

The repulsion induction motor has oil-ring bearings and starts up as a repulsion motor, but when once up to speed it operates as a straight induction motor. It is a commutator type of machine with a device for short-circuiting the commutator at a speed close to the full-load operating speed.

Motors of this class are capable of exerting a large starting torque with minimum line current. They will exert a starting torque 600% of normal with 250% of full-load current. These motors also have excellent operating characteristics such as power-factor, efficiency, speed regulation, etc., and the design is so well balanced that no one characteristic has been sacrificed in order to gain unduly in some other characteristic. These features make them particularly well fitted for use in connection with domestic refrigerators, air compresors, coffee mills, meat grinders, meat saws, grinding and buffing machines, organ blowers, oil pumps, water pumps, small woodworking machinery, small casting-cleaning machines for foundries, small metal-working machines such as hack saws and drill presses, vacuum cleaners, sign flashers, ice cream freezers, shoe power machines, type-setting machines, laundry machines, floor-polishing and washing machines, etc.

Simplicity of construction which tends toward the elimination of many small and intricate parts is one of the outstanding features of these motors. The stator construction consists of a number of circular punchings riveted between two end heads which latter support the bearing housings and the feet or base plate of the motor. No yoke is used and the punchings are exposed directly to the surrounding air. The stator slots are semiclosed, and a simple type of winding for connection to the source of power is used. Four leads are brought out through suitable outlets so that by making different connections the motor can be used on either 110 or 220-volt circuits. The rotor has semiclosed slots which are skewed to obtain uniform turning effort during starting, and a simple type of winding from which connections are made to a horizontal type of commutator. These, in conjunction with other features of the design have the effect of producing quiet and smooth running conditions so essential with this kind of a motor.

The short-circuiting device consists of a circular dished plate split at the outer edge, which operates against a spring by means of weights actuated by centrifugal force when the armature revolves. The whole mechanism is located on the commutator end of the



Allis-Chalmers 0.25-hp., 110-Volt, 60-Cycle, Single-Phase Repulsion Motor.

armature and is integral with it. When a certain predetermined speed near the full-load speed is obtained the weights overcome the spring action and the circular dished plate short-circuits the end of the commutator. Such a mechanism avoids entirely any friction between stationary and revolving parts during the starting period, and also during periods of possible low-voltage line conditions. It is extremely simple in construction and operation and has a minimum number of parts. The fact that the brushes are never raised from the commutator (and a point not to be lost sight of is that the brushes carry and commutate currents only during the starting period) also eliminates a number of delicate mechanisms which further tends to simplicity and reliability of operation.

By shifting the position of the brush holders from *R* to *L* (Right to Left), corresponding to the markings on the front bearing housing, the direction of rotation can be reversed and thus made suitable for any required condition.

The feet are slotted as well as being provided with cored holes for holding-down bolts, thus facilitating the mounting for the various kinds of applications. The motors are readily adaptable for either side-wall mounting or ceiling suspension by shifting the housings.

These motors are entirely automatic in operation. They require no compensators or clutch pulleys and start up under load conditions by closing the circuit through any ordinary knife switch, snap switch or other approved type of switch. In addition to being able to start in sight of the operator these motors can also be started from a distance, and in this respect they are suitable for various forms of remote control such as for use with float switches, pressure systems, etc. As they are automatic in starting any interruption to the power system will not affect the starting up of the motors automatically as soon as power to the lines is restored.

The split-phase type of motor varies considerably in construction and operation from the repulsion motor. It has no commutator and exerts relatively small starting torque with larger line current than that required by the repulsion type. The stator is provided with two windings—a starting winding and a running winding—which necessitates an automatic switch embodied in the machine. This allows the machine to start on a fine-wire starting winding, and when the rotor reaches a predetermined speed which is near the full-load speed the starting winding is cut out of circuit and the running winding is then connected to the same source of supply.

These motors are of the clutchless type and have wick-oiled bearings. They are capable of exerting 150% of full-load torque with instantaneous starting currents varying from 500% to 650% of full-load current and a maximum breakdown torque of 200% of full load with normal voltage and frequency applied directly to the motor terminals. The time of starting or of the maximum current averages from 1 to 2 sec. The motors also have good characteristics such as power-factor and efficiency, which remain at high points throughout the range of the working loads encountered.

Due to their peculiar inherent characteristics these clutchless motors can be successfully used on all applications where moderate starting torque, not exceeding full-load torque, is required, and where, owing to the size of the motor or the rules of the central station, the value of the starting current is not objectionable. They are particularly adaptable for washing machines, ironing machines, folding machines, duplicating machines, meat slicing machines, coffee grinders, water pumps, dish washers, etc. For applications, such as dish washers and washing machines, the motors are made semi-inclosed and splash proof so as to exclude water and other small falling objects. yet at the same time the construction is such that ample ventilation is not interfered with. These motors are usually supplied with a connecting cord and plug. For all other applications where the semi-inclosed features are not required the motors can be supplied as open machines with two binding posts for connection to the source of supply.

The stator construction with the exception of the windings is practically

identical to that of the repulsion motor. No yoke is used and the punchings are exposed directly to the surrounding air. As stated above, a starting winding and a running winding are used, but two leads only are needed, and the machines are wound for one of two voltages only—110 or 220 volts. The rotor has the regular type of squirrel-cage winding consisting of one small copper bar in each slot, the ends of all the bars being riveted and sweated to composition-metal rings, which forms a complete short-circuited winding. As in the repulsion motor the slots are skewed, and this in conjunction with other features of the design has the effect of producing uniform starting torque during the starting period and smooth quiet operation when running at full speed.

On the rear end of the rotor there is a plate centrifugal device whose motion, due to rotation of the rotor, is transmitted by two small rods passing through the rotor core to a small switching device on the front end housing of the machine. This centrifugal device works against a spring so that by proper adjustment the weights can be made to act at a predetermined speed near the full-load speed, thus operating the switch which transfers the line energy from the starting to the running windings of the stator or primary member. The switch, which is apt to be one of the weak points of design, has been given special attention by the Allis-Chalmers engineers so that the construction—rugged yet simple in action—is such as to be characteristic of the entire motor. The switch construction is made to insure maximum life of the contacts, thus insuring maximum service and maximum reliability of operation.

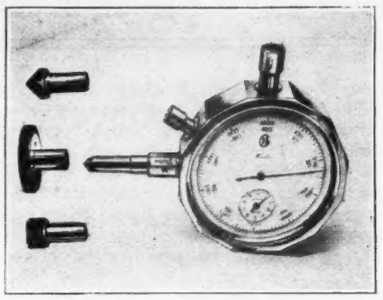
In general appearance the split-phase motor is similar to the repulsion motor, with the exception that the omission of the commutator allows the use of similar housings on each end of the machine. These housings are also arranged so that they can readily be shifted for side-wall or ceiling suspension, and similarly the feet have the cored holes and slotted features tending for accessibility and ease of mounting. All motors have a dull black finish making them attractive and pleasing in appearance and possessive of good wearing qualities in keeping with the other features of their design.

Portable Instrument for Speed-Testing Purposes.

The Hasler speed indicator, which is distributed by the Consolidated Instrument Co. of America, 461 Eighth avenue, New York City, is a useful instrument, owing to the fact that it is portable and adaptable wherever it is desired to test speeds of any kind directly. It is particularly useful about research, experimental and testing laboratories, power plants, electric motors, steam and water turbines, etc., or wherever it is necessary to note revolutions per minute, lineal speeds, machine tool cutting speeds, etc., directly without special driving devices.

The mechanism of the Hasler speed indicator is made up primarily of two units, viz., a fine watch movement and a geared revolution counter. These units are synchronized, one with the other, and combined to form the completed mechanism. Due to their synchronization the operation of the units is entirely automatic and therefore requires no attention from the person operating the instrument.

The Hasler speed indicator is produced in two models. Type A has a



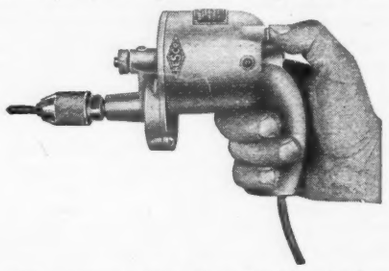
Hasler Speed Indicator.

direct reading range from 0 to 10,000 r.p.m., the scale being graduated as finely as 2 r.p.m. This instrument is recommended for any speed within its range, where it is not necessary to read closer than 2 r.p.m. Type B has a direct reading range from 0 to 1000 r.p.m., the scale being graduated as finely as 0.2 r.p.m. This instrument is recommended where a large range is not desired and where it is necessary to measure speeds within limits of a small fraction of a single revolution.

Electric Drill for Boring Holes in Wood and Metal.

A compact and serviceable electric drill for light work has recently been placed on the market by the Knight Engineering & Sales Co., 447 East Third street, Los Angeles, Cal. This device is known as the "One-Hand-Y" drill and its advantages are thus set forth by the manufacturer:

It is useful for drilling holes for oil, cotterpins, nameplates, or any small hole



The "One-Hand-Y" Electric Drill.

in metal; boring holes for wood screws in cabinet work; dowel-pin holes in window sash; applying hardware in all its ramifications, and for drilling holes for wire in reinforced concrete work. The housing is made of aluminum. The pistol grip is designed to fit the hand perfectly, the grip being on a direct line with the chuck, giving a straight line pressure on the drill bit and eliminating the danger of side strain. A switch button operated by the thumb controls the power, and the motor cannot run idle when not in use.

The manufacturer states that the motor is guaranteed to carry a ¼-in. drill bit through steel as fast as the work requires, at a chuck speed of 900 r.p.m. The motor is air-cooled and of the Universal type, designed to run and operate from either a-c. or d-c., 110-volt circuit. The chuck spindle bronze gear is driven from a spiral-cut steel pinion, integral with the ground and hardened armature shaft. The spindle has a large bronze bearing, and the thrust bearing is a loose steel ball in bronze bushings. A knurled nut on the extended end of the armature shaft makes a quick and simple method of holding the chuck spindle stationary while removing the drill-bit.

The "One-Hand-Y" drill is regularly equipped with 6 ft. of cord, with separable plug, and a 3-jaw chuck, taking ¼-in. drill-bits. The drill is 8 ins. long and weighs 3 lbs. Sanford Brothers, 30 West Walton place, Chicago, are sales representatives for the Knight Engineering & Sales Co., manufacturer of this device.

Tubular Flashlights Designed for Outdoor Use.

Two new types of tubular flashlights—called "Spotlights," because of certain features which concentrate the light rays and center them on a "spot" at distances never before possible with a flashlight—are announced by the American Ever Ready Works, Long Island City, N. Y. These new spotlights are the result of more than 2 yrs. of scientific study and experiment. To perfect them, Ever Ready company has created a scientific parabolic reflector, a new "Eveready" mazda lamp of increased brilliancy and power, and an exclusive focusing device by which the light can be brought to as sharp a point as desired merely by turning the end cap.

A new shock absorber underneath the lamp prevents breakage in case the flashlight is accidentally dropped or jarred. Most ingenious of all, however, is a compartment the same size and style of the ordinary end cap, which holds two extra mazda lamps so that no flashlight need be put out of business just because a lamp burns out. The end cap of this new flashlight is stamped to show the renewal type of battery and lamp required, and it becomes increasingly easy to keep the spotlight "bridled and saddled and ready to go"—alert for every emergency where portable and safe light is desired.

"Eveready" advertising in national publications will feature "the new 'Eveready' Spotlight with the 300-ft. range," for with this powerful light objects can readily be "spotted" at this or even greater distances. It is essentially an outdoor light, and in the out-of-doors its scope of usefulness is practically unlimited. For motoring—picking out road signs at night; for boating—finding mooring or landing; or for night "flash" signaling, the lamp will be found useful.

"We consider these the most remarkable improvements in the history of the flashlight business," says Emmet K. Moore, assistant general sales manager of the American Ever Ready Works. "In a comparatively few years we have seen the flashlight develop from a toy or novelty to its present scientific basis. The fact is that the flashlight is the most important necessity of all forms of light. It is safe, portable, instantaneous. With it, you can have light where light is needed most; without it, one is subjected to the hundreds of dangers which lurk in darkness.

ACTIVITIES IN THE TRADE

Business Developments, Sales Agencies, Trade Literature and Miscellaneous Items Concerning Electrical Manufacturers and Allied Business Interests

Pure Carbon Co., Wellsville, N. Y., has issued catalog No. 3 covering its line of "pure" carbon brushes for motors and generators.

G. Schoenfeld, 126 West 21st street, New York City, electrical contractor, plans to enlarge his present place of business in the near future.

Big Sandy Electrical & Repair Co., Pikeville, Ky., of which E. S. Shurtleff is president, plans to erect a machine shop and electrical repair works.

I. H. Wells, 2028 North Major avenue, Chicago, has awarded contracts for a 2-story washing-machine factory at 21 North Major avenue, to cost about $20,000.

Allis-Chalmers Manufacturing Co., Milwaukee, has issued bulletin No. 1114, illustrating and describing its type "R" potential starters for squirrel-cage induction motors.

Star Porcelain Co., Muirheid avenue, Trenton, N. J., manufacturers of electrical porcelain products, has completed plans for the erection of a 2-story addition, 30 by 100 ft. Herbert Sinclair is head.

Western Battery & Supply Co., 224 West Broadway, Enid, Okla., of which J. G. Wright is vice-president and manager, has acquired a building for its new plant to manufacture electric storage batteries and accessories.

Bauman & Loeb, 138 Bowery, New York City, manufacturers of electrical fixtures, has opened a sales office at 153 North Michigan avenue, Chicago, where samples will be shown and stocks carried for the service of Western contractor-dealers.

G. M. Basford Co., formerly located at 30 Church street, New York City, has announced that it, as well as the Franklin Railway Supply Co., Inc., American Arch Co., Inc., Lima Locomotive Works, Inc., The Superheater Co., and the Rome Iron Mills, Inc., are now occupying new general offices at 17 East 42d street, New York City.

Electric Storage Battery Co., Allegheny avenue and 19th street, Philadelphia, manufacturer of storage batteries, has erection under way on a total of 17 buildings at its new plant at Crescentville, near Philadelphia, and plans are ready for another group of 10 buildings, making a total of 27 buildings forming the new works.

Electric Furnace Construction Co., 908 Chestnut street, Philadelphia, has announced that the 10-ton "Greaves-Etchells" electric furnace installed by its English office at the works of the Sociedad Espanola de Construccion Naval, Spain, has been successfully started up. It is stated that this is the first large electric furnace to be operated in Spain.

Coffield Washer Co. of Canada, Ltd., 121 South James street, Hamilton, Ont., which was recently incorporated with a capital of $50,000 to manufacture electric washers for the Canadian trade, is the Canadian branch of the Coffield Washer Co. of Dayton, O. The officers of the Canadian company are: President, Harry Bloom; vice-president, Walter C. Brittain; secretary and treasurer, Albert E. Trimble, and director, J. L. Coffield.

Ilg Electric Ventilating Co., 2850 North Crawford avenue, Chicago, has made the following announcement: "On Saturday, April 23, a carload of 'Ilg' ventilating fans and blowers left this plant for Philadelphia. This carload shipment consists of fans and blowers sold in and around Philadelphia. Does not this sound like prosperity returning?"

Bleadon-Dun Co., 213 South Peoria street, Chicago, manufacturer of electromedical apparatus, has announced the establishment of an office at 830 Washington street, Boston, in charge of William E. Alcott and J. Bernard Lynch. A stock of Bleadon-Dun "Violet Ray" machines will be kept on hand at the eastern office to take care of the New England trade.

Worthington Pump & Machinery Corp., 115 Broadway, New York City, has purchased the plant additions and improvements made by the government during the war period at its Hazleton (Pa.) plant, with cost approximating $4,000,000. The acquisition places the Worthington company in complete control of the local factory, and it is said that plans are under way for an early resumption of manufacturing operations. The plant has been closed for a number of months.

Atlas Valve Co., 282 South street, Newark, N. J., has issued bulletin No. 1-A, illustrating and describing "Ideal" pump governors. The bulletin contains photographs of finished pump governors, shows cross-sectional drawings with all parts numbered, and explains the installation and operation of the equipment. It also includes descriptions of the "Ideal" pump governor for turbine or reciprocating steam-driven pumps for marine or stationary turbines and other purposes.

Bleadon-Dun Co., 213 South Peoria street, Chicago, manufacturer of electromedical apparatus, has announced the opening of an office in New York City at 25 West 42d street, in charge of M. H. Sarben, who was formerly export manager for the Theodore Stave Co., export representative for the Bleadon-Dun Co. Mr. Sarben is well acquainted with the line of "Violetta" and "Violet" ray machines made by the Bleadon-Dun Co. through his former connection with the Theodore Stave Co.

Batterman-Truitt Co., 736 West Monroe street, Chicago, manufacturer of motor-driven fans and blowers, has announced that in order to provide for the steady growth of its business it has taken over additional manufacturing space in the Gordon building, 730-38 West Monroe street, which will triple its facilities and equipment for the manufacture of its products. The officers of the company are: President, Joseph E. Truitt; vice-president, Emil Ackerman, and secretary-treasurer, Theodore F. LeJeune.

Frederick Engineering Co., Frederick, Md., has issued a loose-leaf form of catalog on the Frederick underfeed stokers. The first section is devoted to the construction of the stokers, containing a detailed description with illustrations of the mechanism. In section two, line cut and halftone reproductions of Frederick stoker installations are shown. Engineering data is the subject of the third and last section. It gives general information and data for the consulting or power-plant designing engineer and contains 33 illustrations, depicting the various types of Frederick stokers and including graphic charts of performance curves and relative results.

George A. Johnson Co., Inc., 150 Nassau street, New York City, has announced the reorganization of Johnson & Benham, Inc., under the name of the first-mentioned firm, the members of which are George A. Johnson, Nelson B. Wolfe, Harold C. Stevens and Charles R. Wyckoff, to engage in the professional practice of civil, electrical and mechanical engineering. Memberships are held in the National Electric Light Association, American Institute of Electrical Engineers, American Society of Mechanical Engineers, American Society of Civil Engineers.

Western Electric Co., 110 Williams street, New York City, has issued a special advertising manual for its power and light dealers. This publication, which is known as the "Western Electric Power and Light Business Builders for 1921," is a substantially bound book, handy in size and convenient to use as a comprehensive year-round reference. From the message-bringing two colored cover on the front page to the attention-attracting five colored sticker on the last page, this encyclopedia of advertising helps is replete with practical helpfulness. The manual covers every phase of the power and light dealer's field and includes within its scope every kind and type of sales helps. It includes a booklet worthy of special mention. It it designed to assist dealers in the development of their local newspaper advertising, and is claimed to be an innovation in "prepared publicity." In the book are 52 ads (one for each week of the year) and 52 news stories that tie up to them. Each ad and each story is written in a friendly and intimate style that is full of human interest and will help to get across the story of Western Electric power and light.

PERSONAL MENTION

Biographical Sketches and Chronicle of Changes in Business Connections, Promotions and Other Personal News of the Industry

JAMES E. WATSON has been appointed general manager of the Elliott Co., Jeanette, Pa., manufacturer of power accessories.

GEORGE B. TROXELL has resigned as assistant superintendent of the electric furnace and crucible departments of the Bethlehem (Pa.) Steel Co.

ALEXANDER C. BROWN, president of the Brown Hoisting Machinery Co., Cleveland, has been elected president of the Cleveland Chamber of Commerce.

R. F. HARRISON has been appointed district manager of the Cleveland Electric Motor Co., and will make his headquarters at 1242 Monadnock block, Chicago.

D. N. FINLAYSON, formerly general manager of the Detroit Pneumatic Chuck Co., has been appointed factory manager of the Tideman Electric Manufacturing Co., Cairo, Ill.

WALTER HALL, 305 Merchants Bank building, Indianapolis, Ind., has been appointed resident engineer for Indiana and Southern Illinois for the National X-Ray Reflector Co., of Chicago.

E. E. EBY, formerly American director of Delco-Remy, Ltd., and Hyatt, Ltd., with offices in New York City, has become connected with the Remy Electric Co., Anderson, Ind., as purchasing agent.

A. S. JOURDAN, formerly superintendent of the Waterbury (Conn.) district of the Connecticut Light & Power Co., has been appointed superintendent of the New Britain district to succeed N. S. Franklin, who has resigned.

ROBERT DOBLE has been appointed on the staff of the Metals Exploration Co., New York City, as consulting engineer with respect to electric and hydroelectric power installations and operations. He will make his headquarters at 201 14th street, Denver, Colo.

VICTOR T. GOGGIN, late New England sales manager of Fred T. Ley & Co., Inc., of Springfield, Mass., Boston and New York City, has severed his connection with that concern to associate himself as contracting engineer with Dwight P. Robinson & Co., Inc., of New York City, Chicago, Dallas, Youngstown, Los Angeles and Montreal.

W. A. WOLFF, of the Western Electric Co., was elected president of the Technical Publicity Association of New York at the annual election of that organization held recently. The new executive was first vice-president of the Association last year. He has been a member of the staff of the Western Electric Co.'s advertising department, 195 Broadway, New York City, for several years, in charge of service and production. The other new officers of the Technical Publicity Association of New York are: First vice-president, G. W. Vos, Texas Co.; second vice-president, Cyril Nast, New York Edison Co.; treasurer, R. P. Kehoe, and secretary, O. E. Bostwick, Sprague Electric Works of General Electric Co. The executive committee consists of H. J. Downes, W. B. Rufe, W. E. Kennedy and Charles F. Baur.

W. J. MARSHALL, who recently resigned the position of sales manager of the Electric Construction & Sales Co., Cleveland, has been made promotion manager of the Erner Electric Co., jobber, of the same city. He will be in

W. J. Marshall.

general charge of the appliance sales promotion work. Before going to Cleveland, Mr. Marshall was for 11 yrs. connected with the Doherty interests as new-business manager in Toledo and Warren, O. He has been prominent in both the National and Ohio Electric Light Associations and in the work of the Electrical League, in which latter organization he served as chairman of the committee which so successfully launched the "Home Electrical" movement in Cleveland.

T. I. JONES, general sales agent of the Brooklyn Edison Co., in an address on "The Industrial Development of Brooklyn," delivered recently before the Brooklyn Rotary Club, in addition to pointing out the waterfront and terminal developments of the city, freight facilities, etc., and giving statistics on its manufacturing activities, stated that during the month of January, 1919, the maximum demand of all electric current used at a given time for the industries, stores and houses of the borough amounted to 103,200 hp.; in January, 1920, 138,600 hp., or an increase of 34%. But for the recent industrial depression a similar increase would have occurred in January, 1921, he said.

WILLIAM J. MACPHERSON has been appointed chairman of the Central Committee on Co-operation of the Public Service Co. of Northern Illinois, 72 West Adams street, Chicago, in place of J. L. Hecht, who was recently elected assistant to Vice-president Frank J. Baker. Mr. MacPherson began his employment with the Northwestern Gas, Light & Coke Co. in 1911, joining the organization of the Public Service Co. of Northern Illinois when it took over the properties of the former corporation. He was in charge of Blue Island Station No. 27. On being mustered out of army service in 1918 he was made superintendent of district "O."

OBITUARY.

ALBERT M. CHAPMAN, manager of the Shenandoah River Light & Power Corp., Louray, Va., died April 17, aged 34 yrs. He had occupied his position with the company for about 2 yrs., succeeding Emmitt Rankin.

MONTGOMERY CLARK, sales representative of the Bryan-Marsh Division, National Lamp Works of General Electric Co., 33 Union square, West, New York City, died April 20, in his 50th year. Funeral services were held at Demariscotta Mills, Me.

PRESTON KING YATES, consulting engineer, with offices at 120 Broadway, New York City, and residing at 227 Brooklyn avenue, Brooklyn, N. Y., died April 22 at the age of 63 yrs. He was a graduate of the Rensselaer Polytechnic Institute, class of 1880, and a designer and builder of many stone-crushing plants throughout the United States. During the world war he served as consulting engineer for the U. S. Government at the Muscle Shoals plant. Mr. Yates was a member of the American Society of Civil Engineers, American Society of Mechanical Engineers and the Ohio Society of New York. He is survived by a widow, a son and a daughter. The funeral services were held at his birthplace, Canajoharie, N. Y.

W. H. TRENNER died recently in New York City, at the age of 43 yrs. He had been chief engineer and superintendent of power for the Idaho Power Co., Boise, Idaho, since 1915, and previous to his connection with that company had held positions as general superintendent of the Idaho-Oregon Light & Power Co. and the Idaho Railway, Light & Power Co.

WILLIAM A. LYNN died at San Francisco April 10. He was born at Salinas, Cal., in October, 1873, and graduated from the University of California in 1897, where he stayed until 1902 as an instructor in electrical engineering. In 1908 he was appointed consulting engineer with the U. S. Government headquartrs at the Mare Island Navy Yard, which position he held at the time of his death. Mr. Lynn had been a member of the American Institute of Electrical Engineers since 1899.

BUSINESS OPPORTUNITIES

News of Electrical Construction Projects in All Parts of the Country, Proposals Invited, Foreign Trade Openings and New Companies

EASTERN STATES.

Lincoln, Me.—Machinery to be installed in the worsted mill to be erected by the Lincoln Worsted Co., will be electrically operated. The company was recently organized with a capital of $600,000, and the new mill is estimated to cost $100,000. L. J. Coburn is manager. F. A. Petterson, 16 Central street, Bangor, Me., is architect.

Athol, Mass.—The Board of Education has arranged for an appropriation for the installation of electric lights and equipment at the local school buildings.

Boston, Mass. — Electric motors, belting, shafting and other transmission equipment will be installed in the factory of the Windham Manufacturing Co., 263 Summer street, South Boston.

Fall River, Mass.—Considerable electrical equipment will be installed in the 3-story addition to be erected at the plant of the Lincoln Manufacturing Co., North Main street, estimated to cost $300,000.

Longmeadow, Mass. — Electrical equipment will be installed in the proposed automobile truck assembling plant to be established by the Martin Rocking Fifth Wheel Co. Plans for the work are under way.

Pittsfield, Mass.—The Department of Public Utilities has granted permission to the Pittsfield Electric Co. to issue stock in an amount of $250,000 to be used for general operations, extensions and improvements.

Hartford, Conn.—Considerable electrical and mechanical equipment will be installed in the laundry plant to be erected by the Board of Health, in co-operation with the city Board of Charities. The new laundry is estimated to cost $75,000 with equipment.

Brooklyn, N. Y.—The Brooklyn Edison Co., 360 Pearl street, has been granted permission by the Public Service Commission to issue $1,000,000 in 2-year bonds. The proceeds will be used for general operations, improvements, etc.

Brooklyn, N. Y.—Electrical and mechanical equipment, refrigerating machinery, etc., will be installed in the refrigerating plant to be constructed by the Brooklyn Butchers Corp., 3285 Fulton street, at Atlantic avenue and Fort Greene place. The plant will cost about $250,000.

Long Beach, N. Y.—The Long Beach Power Co., Park street, has awarded a contract to Johnson & Molitor, Long Beach, for the erection of a 1-story power plant to cost about $125,000, with equipment.

New York, N. Y.—Preliminary plans are under way for the erection of the proposed municipal electric light and power plant at the ferry terminal, St. George, S. I., estimated to cost $1,250,000. The project will be carried out by the Department of Plants and Structures, Grover A. Whalen, director.

New York, N. Y.—Electric traveling cranes, hoisting and conveying machinery will be installed on the new piers now being constructed by the city of New York at a point between Tompkinsville and Clifton, S. I. A total of 12 piers will be erected at a cost of about $20,000,000, varying in width from 125 to 290 ft., and in length from 1030 to 1200 ft. A number of the piers have been leased by private companies, and it is proposed to have the structures equipped and ready for service early in the fall.

New York, N. Y.—The Western Union Telegraph Co. has placed orders for a total of 10,000,000 lbs. of copper wire for line construction. The company plans to construct over 35,000 mi. of new lines, and is expected to be in the market for additional quantities of wire, closely approximating the first purchase, at an early date.

New York, N. Y.—The Hotel Chelsea, West 23d street, is arranging for the installation of new electrical equipment. The former power plant at the hotel will be disposed of, and central-station service used, with electric energy from the lines of the New York Edison Co. New electric elevators and pumps will be installed.

Niagara Falls, N. Y.—The Niagara Falls Power Co. has filed notice of increase in its capital stock from $15,000,000 to $20,000,000. The company will proceed at once with the construction of its proposed hydroelectric generating plant, increasing its present generating capacity to 400,000 hp. The new plant is estimated to cost $10,000,000.

Perry, N. Y.—The Perry Light Co. has been granted permission by the Public Service Commission to construct an electric power plant. Distributing lines will be built to serve different sections of Genesee Falls township.

Roxbury, N. Y.—The Roxbury Light & Power Co. has been incorporated with a capital of $20,000, by J. H. Dart and others.

Utica, N. Y.—Considerable electrical and mechanical equipment will be installed in the automobile service and repair building to be erected by the Utica Motor Car Co., Kent avenue. The new plant is estimated to cost $250,000.

Hammonton, N. J.—Electric equipment will be installed at the proposed new sewerage disposal plant to be constructed by the Board of Township Commissioners at a cost of about $25,000. Remington & Vosbury, Sixth and Market streets, Camden, N. J., are engineers.

Newark, N. J.—The Broad Street Improvement Association is negotiating with the City Commission for extensions in the street-lighting system on Broad street to the Lackawanna railroad station to the north, and to Lincoln Park to the south.

Paterson, N. J.—Electrical equipment will be installed in the 1-story dye plant to be erected on Jersey street by the Modern Central Silk Finishing Co., 18-24 Market street, at a cost of about $40,000.

Perth Amboy, N. J.—The City Electrical Bureau, Jay B. Franke, city electrician, will commence work at once on the installation of a new "white way" street-lighting system on Madison avenue, from Market to Fayette streets.

Sea Isle City, N. J.—The Electric Light, Power & Water Co. has been granted permission by the Board of Public Utility Commissioners to dispose of its electric power plant at Sea Isle City to that municipality for a consideration of $67,500. The Friars Gas Co. of New Jersey has received similar permission regarding its local gas plant. In the future the plants will be operated as municipal properties.

Ventnor City, N. J.—The Board of Public Works has awarded a contract to J. L. Sweigart & Co., Lincoln building, Philadelphia, for the erection of a power house at the municipal waterworks.

Allentown, Pa.—The Pennsylvania Power & Light Co. is planning the installation of equipment at an early date at the addition to its generating plant at Hauto, now in course of erection. It is proposed to have the plant ready for operation early in the fall. It will double the capacity of the present station, and is estimated to cost $3,000,000. The company is considering the erection of a machine shop on property adjoining the power plant.

Bakerstown, Pa.—The Pittsburgh Cut Flower Co., Seventh avenue, has awarded a contract to the G. Schenk Co., Butler, Pa., for the erection of its power house at Bakerstown to cost about $45,000.

Ellwood City, Pa.—The Public Service Commission has issued an order for the Harmony Electric Co. to discontinue the construction of a distributing line in this section for the purpose of furnishing electric energy to local consumers. This action has been taken on the complaint of the Pennsylvania Power Co.

Gettysburg, Pa.—The Adams Light & Power Co. is being organized to build an electric power plant, with transmission and distributing lines to furnish service in the entire northern section of Adams county. The dis-

tricts to be included in the new system are Bendersville and York Springs borough; Menallen, Tyrone, Hamilton, Huntington, Butler, Latimore and Reading townships.

Hazleton, Pa.—Electrical equipment will be installed at the ice plant to be constructed by the Hazleton Ice Manufacturing Co., estimated to cost $25,000.

Harrisburg, Pa.—The Public Service Commission is considering the application of eight new electric companies to operate in Bedford county, headed by the Bedford Electric Co.

Lansdale, Pa.—The Towamencin Electric Co. has acquired an electric line extending from Lansdale to the vicinity of Kulpville for extensions in its distributing system.

Newtown Square, Pa.—The board of directors of the Dunwoody Home is taking bids for the erection of a power house at the institution.

Obisonia, Pa.—The Obisonia Light Co. has been incorporated with a nominal capital of $5000 to construct and operate a local electric light and power plant. William G. Lucas, Albert and S. E. Locke, Obisonia, are the incorporators.

Philadelphia, Pa.—The Electrical Bureau, in co-operation with the Department of Highways, is planning for the installation of new electrically operated traffic signaling devices at important street intersections in the business district.

Philadelphia, Pa.—The Transit Department has awarded a contract to the Westinghouse Electric & Manufacturing Co., Pittsburgh, for motor equipment for cars for the municipal Frankford elevated railway line, at a cost of about $220,000.

Pittsburgh, Pa.—The Philadelphia Co. is arranging for a bond issue of $10,000,000 for its subsidiary, the Duquesne Light Co., the proceeds to be used for general operations, extensions, improvements, etc.

Pittsburgh, Pa.—The Pennsylvania Light & Power Co. has made application to the Public Service Commission for permission to acquire the properties of the Pennsylvania Light, Heat & Power Co.

Baltimore, Md.—The Standard Oil Co., Pratt street, is planning the erection of a power plant at Third avenue and Second street.

Baltimore, Md.—The American Sugar Refining Co. has filed plans for the erection of a 1-story power house at Clement and Woodall streets, to be 110 by 130 ft. Stone & Webster, 120 Broadway, New York City, are engineers.

Baltimore, Md.—The Consolidated Gas, Electric Light & Power Co. has made application to the Public Service Commission for permission to arrange a plan requiring new customers to finance extensions and service connections. Hearings will be held on the application at once.

Betterton, Md.—The Common Council has plans under way for the installation of a local electric-lighting system.

Baltimore, Md.—Electrical equipment will be installed by the Park Arrow Laundry Co., at its building to be erected on Pulaski street.

Baltimore, Md.—The American Agricultural Chemical Co. is replacing all steam operation entirely at its local plant with electrical service. Arrangements have been made for the installation of motor equipment with an aggregate of 450 hp., being an extension of the 1000 hp. installation made by the company during the past year.

Baltimore, Md.—The City Electrical Bureau reports a total of 63 power installations made during March for industrial plants in the municipality, 33 of which were extensions to established works. More than 8% of the local industrial plants are now running exclusively with electrical power.

Piedmont, Md.—The Piedmont Electric Light & Power Co. has entered into an agreement with the Edison Electric Illuminating Co., Cumberland, Md., for a supply of power for furnishing service at Piedmont, Westernport and Luke. The local distribution will be handled by the Piedmont company.

Halifax, Va.—The Halifax Power Co. has commenced the construction of a hydroelectric power plant on the Bannister river with capacity of about 1350 hp. The plant will be used for local service, with distributing system extending to South Boston, Va. It is estimated to cost $350,000 with machinery.

Newport News, Va.—The Newport News & Hampton Railway, Gas & Electric Co. has filed notice of increase in its capital stock from $4,000,000 to $5,000,000 for extensions. J. N. Shannahan is president.

Winchester, Va.—The Northern Virginia Power Co. has executed a mortgage covering its property in West Virginia, Virginia and Maryland to an amount of $5,000,000, in the name of the Fidelity Trust Co., Baltimore, Md.

Buckhannon, W. Va.—The Buckhannon Light & Water Co. is planning the construction of an electric power plant, 38 by 75 ft., to cost about $75,000. L. Hudson, Wabash building, Pittsburgh, is engineer.

Petersburg, W. Va.—The Community Power Co., recently organized, is planning the construction of a transmission line to Moorefield, W. Va., about 12 mi. R. W. Baker is manager.

Wheeling, W. Va.—The Whitaker-Glessner Co. is planning the construction of a power plant at its steel plant at Manchester to cost about $50,000.

Ahoskie, N. C.—The Common Council is planning a bond issue of $40,000 for the installation of an electric system.

Asheville, N. C.—The French Broad River Development Co., Hendersonville, N. C., is having surveys made for hydroelectric development, to include a dam 100 by 125 ft. high on the French Broad river. Address J. H. Pratt, engineer, Chapel Hill, N. C.

Hickory, N. C.—The Berry-Fortune Construction Co., Hickory, has received contracts for the construction of two hydroelectric power plants in this section for textile mill operation. The first plant will be erected by the Falls Manufacturing Co., Granite Falls, N. C., on the upper Little river, and the other by the North State Cotton Mills, Taylorsville, N. C., on the lower Little river.

NORTH CENTRAL STATES.

Cincinnati, O.—Plans are being prepared by City Electrician William O. Kleine for a new lighting system for the city.

Detroit, Mich.—The request of the Public Lighting Commission for $50,000 with which to prepare plans for a new power plant will be granted. Address Mayor Couzens.

Athens, Ill.—Bonds to the amount of $25,000 have been voted to construct an electric light plant between the waterworks near Springfield and Athens. Address the mayor.

Belvidere, Ill.—Alderman Robinson, of the Electric Light Committee, has recommended that additional street lamps be installed.

Freeburg, Ill.—Bonds to the amount of $25,000 have been voted for an electric light plant. Address Dr. C. L. Tegtmeier, mayor.

Freeport, Ill.—A number of property owners residing on Lincoln boulevard are endeavoring to interest all property owners on that thoroughfare to have a boulevard lighting system installed there. Address city clerk.

South Elgin, Ill.—Bonds to the amount of $5000 have been voted for the installation of electric lamps on streets, alleys, avenues, sidewalks, parks and public grounds of the town. Address the mayor.

Waukegan, Ill.—The City Council has passed the ornamental lighting system plans which have been under consideration for several months. It is planned to have the lighting system in operation early in the fall. Address secretary of the Chamber of Commerce.

Hurley, Wis.—A "white way" lighting system will be installed in the city. Address E. B. Williams, city clerk.

Oconomowoc, Wis.—The city is considering plans for improving the municipal electric plant. Address the mayor.

Racine, Wis.—The committee having charge of the plan to extend an electric power and light line from Rapids road to Franksville and Thompsonville have filed their request with the Milwaukee Electric Railway & Light Co., Public Service building, Milwaukee.

Sioux City, Ia.—J. B. Mann, head of the Public Safety Department, recommends that more than 200 new street lamps be installed in the city this year.

St. Louis, Mo.—On motion of President Aloe of the Board of Aldermen, the Board of Estimate and Apportionment has adopted a resolution favoring a bond issue of $10,000,000 for street repairs and completion of the city's electric street-lighting system. The bond issue will be sub-

mitted to the voters at a special election next fall.

Minneapolis, Kan. — The Town Council will investigate lighting plants to ascertain the best equipment to be adopted for the municipal plant. Address the mayor.

Brookings, S. D.—The Commercial Club has indorsed the proposal for the city to issue $60,000 in bonds for the needed improvement to the city light and power plant. Address the mayor.

Worthing, S. D.—Work will start shortly on an electric and distributing plant from Harrisburg. Bonds of $10,000 have been voted for this purpose. Address city clerk.

Jamestown, N. D.—The city plans to install new globes and lamps. Address M. R. Eager, city auditor.

SOUTH CENTRAL STATES.

Dawson Springs, Ky.—The Treasury Department, Washington, D. C., has awarded a contract to the Murch Brothers Construction Co., Railway Exchange building, St. Louis, for the erection of a 1-story power plant at Dawson Springs, to cost about $42,000.

Falmouth, Ky.—The Waterworks Department is having plans prepared for the erection of an electric power plant and pumping station at the municipal waterworks. Glazier & Morlidge, 20 Miller building, Cincinnati, O., are engineers.

Germantown, Tenn.—The Common Council will call for bids at an early date for the construction of a municipal power plant. Gaines & Carlisle, Falls building, Memphis, Tenn., are architects.

Martin, Tenn.—Light and water improvement bonds to the amount of $100,000 will be offered for sale in 6 weeks. Address Frank L. Wilcox, engineer, Chemical building, St. Louis.

Birmingham, Ala.—The Alabama Power Co. is arranging for the issue of bonds for $25,000,000, in accordance with permission granted recently by the Public Service Commission. A portion of the proceeds, including the sale of certain stock, will be used for the construction of the proposed hydroelectric power plant at Duncan's Riffle.

Belzoni, Miss.—The Common Council is planning a bond issue of $25,000 for improvements in the electrical system.

Chickasha, Okla.—The Gay Electric Co., recently incorporated with a capital of $25,000, will operate a local electric system. G. G. Gay and E. L. Hope head the company.

Ballinger, Tex.—The City Council has plans under way for the construction of a municipal electric power plant to cost about $75,000. Bonds for this amount recently have been voted.

Dallas, Tex.—The City Council is planning extensions in the street- and park-lighting system in the Highland Park district to cost about $16,000.

San Angelo, Tex.—The San Angelo Water, Light & Power Co. is planning extensions in its electric power plant to double the present capacity. The new addition, with engine, generator and auxiliary operating equipment, is estimated to cost $70,000. The company is also planning extensions in its transmission system.

WESTERN STATES.

Brigham City (Perry), Utah.—Bonds to the amount of $6000 have been voted for the purpose of purchasing the property of the Perry Electric Light Co. Address the mayor.

Provo, Utah. — Preparatory to launching a project for the development of about 2227 hp. from the Provo river for use in Utah and Wasatch counties, A. N. Taylor, of Provo, has filed a petition with State Engineer R. E. Caldwell for the appropriation of 20 sec. ft. of water. The diverting works will consist of a cement dam in each branch of the north fork creek and a diverting channel some 21,300 ft. in length.

Salt Lake City, Utah.—The Utah Power & Light Co. has filed application with the Public Utilities Commission for a certificate of convenience and necessity to exercise its rights and privileges in the town of Layton. In its application the company sets forth that it has the franchise granted by the city to furnish light, heat, power and other service and to construct such transmission lines and install such other equipment as may be necessary.

Ridgefield, Wash.—The new Ridgefield Light & Power Co. has been organized and proposes to build a transmission line to go through Lake Shore, Fruit Valley, Sara, Felida and Ridgefield, and probably be extended east to Pioneer and north to La Center. Address N. C. Hall, mayor.

Seattle, Wash.—The improvement of University Way from East 40th to East 47th streets by cluster lamps has been proposed by a resolution introduced in the City Council and referred to the City Utilities Committee.

Seattle, Wash.—The Kelly Mines Co., 1212 L. C. Smith building, has applied to the Federal Power Commission for a preliminary permit to divert water from Fishnook creek and the Little Susitna river to a common power house on Fishnook creek, in Knik precinct, 55 mi. north of Anchorage, to be used for power for mining and milling purposes.

Wenatchee, Wash.—Vice-president L. C. Gilman, of the Great Northern Railroad Co., has signed a contract with R. T. Lovell of the Wenatchee Valley Gas & Electric Co., whereby the railroad agrees to build a transmission line from the Tumwater canyon hydraulic plant to connect with the electric company's line at Dryden and deliver 1000 kw. to the company. Frequency changers and transformers will be installed. The cost of the project is estimated at $75,000. The new line will be completed within 60 days.

Wenatchee, Wash.—The Royal Development Co., of which James Naughten is president, has applied to the Federal Power Commission for a license to divert water from Dry creek into Chipmunk creek, in Chelan county, Wash.; also for a proposed power project consisting of a diversion dam to unnamed branch of Phelps creek, to be used for power for mining.

Portland, Ore.—The George Inlet Packing Co., Peninsula National Bank building, has applied to the Federal Power Commission for a license to construct a power plant on George Inlet, 12 mi. from Ketchikan, Alaska, to generate power for canning factory.

Baldwin Lake, Cal.—The Gold Mountain Mining Co. has entered into an agreement with the Southern Sierras Power Co. for the construction of a transmission line to reach its local properties. The line will be about 25 mi. in length.

PROPOSALS.

Cincinnati, O.—Bids will be received May 9 for the complete installation of an electric lighting system in the 12th district public school building, located at Eighth and Melvin streets. Address C. W. Handman, business manager.

Lima, O.—Bids will be received May 9 for the installation of an ornamental street-lighting system. Address Elmer McClain, director of public service.

Portland, Ore.—Bids will be received shortly for the construction of a dam, screen house and small concrete power plant at the headworks of the Bull Run water reserve, which will cost about $230,000. Address Fred Randlett, chief engineer of the Water Bureau.

INCORPORATIONS.

Davenport, Ia.—Davenport Electrical Contract Co. Capital, $20,000. To conduct an electrical contracting business and manufacture electrical goods. Incorporators: H. M. Heysinger, president; Richard Copley, vice-president, and George Hahn, secretary.

Buffalo, N. Y.—Maclowry Electric Co. Capital, $25,000. To manufacture electrical products. Incorporators: J. T. Maclowry, A. H. and J. J. McGovern.

South Manchester, Conn.—Harris Electrical Co., Capital, $2000. To manufacture electrical specialties. Incorporators: J. H., M., and F. S. Harris.

New York, N. Y.—Hartt & Lane, Inc. Capital, $52,500. To manufacture electrical appliances. Incorporators: N. Lane, Jr., J. J. Hartt, and F. H. Field, 29 Liberty street.

New York, N. Y.—Anchor Bronze Co. Capital, $10,000. To manufacture electric fixtures. Incorporators: R. J. Kupferrman, M. Lovitch, and J. Schaefer, 1703 Washington avenue.

New York, N. Y.—The Arc Electrical Construction Co. Capital, $10,000. To engage as electrical contractors. Incorporators: W. Andrie, J. Conlin, and C. Rao, 237 East 53rd street.

Newark, N. J.—Chase Electrical Service Co., 88 Washington street, has filed notice of organization to manufacture electrical specialties. Arthur B. Chase, 577 High street, heads the company.

FINANCIAL NEWS

Comment on the Financial Outlook in the Electrical Industry, New Securities, Reports of Earnings, Dividends and Utility Stocks

Philadelphia Electric Co. Earnings for Last Year.

The annual report of the Philadelphia Electric Co. for the year ended Dec. 31, 1920, shows surplus, after charges and federal taxes, of $2,811,925, equivalent after preferred dividends to $2.26 a share ($25 par value) earned on the $30,000,000 common stock. This compares with surplus of $2,639,037 or $2.22 a share earned on the $29,618,325 capital stock in 1919. The consolidated income account for the year ended Dec. 31, 1920, compares as follows:

	1920.	1919.
Gross	$20,043,335	$16,279,239
Net after taxes	5,375,196	5,244,065
Balance after charges	2,811,925	2,639,037
Preferred dividends.	100,837	.....
Common dividends..	2,099,558	1,932,110
Surplus	611,530	706,927
Profit and loss surplus	4,919,908	4,309,756

United Railways & Electric Co. of Baltimore.

The annual report of the United Railways & Electric Co. of Baltimore for 1920 shows surplus, after charges and taxes, of $1,043,599, equivalent after preferred dividends to $2.54 a share earned on the $20,461,200 common stock ($50 par value) as compared with surplus of $246,424, or 59 cents a share in the previous year. The income account for the year ended Dec. 31, 1920, compared as follows:

	1920.	1919.
Operating revenue	$17,313,598	$14,794,233
Expenses, depreciation, etc.	13,170,262	11,341,211
Net revenue	4,143,336	3,453,022
Other income	120,740	40,117
Total income	4,264,076	3,493,139
Charges	3,220,477	3,246,715
Balance	1,043,599	246,424
Preferred dividends.	383	920
Common dividends...	.....	204,612
Surplus	1,043,216	40,892

Detroit Edison Co. ..

For the 12 mo. ended March 21, 1921, the Detroit Edison Co. shows net income after charges and taxes of $2,125,768. The consolidated statement for the 12 mo. follows:

Gross	$22,677,877
Expenses, depreciation and taxes	17,805,508
Interest	2,746,801
Net income	2,125,768
Dividends	2,214,727
Extraordinary charges	825,748
Deficit	914,707
Previous surplus	2,981,243
Profit and loss surplus	2,066,536

Electric Bond & Share Co.

The annual report of the Electric Bond & Share Co. for the year ended Dec. 31, 1920, shows net income of $2,127,600, as compared with $1,697,471 in the previous year. Comparative income statement follows:

	1920.	1919.
Gross income	$3,564,734	$3,114,871
Net income	2,127,600	1,697,472
Preferred dividends	588,580	563,525
Common dividends	800,000	778,730
Surplus	739,020	355,217
Profit and loss surplus	4,858,204	4,119,184

West Penn Power Co. and Subsidiaries.

Statement of the West Penn Power Co. and subsidiaries for the year ended Dec. 31, 1920, shows surplus after taxes and charges of $1,240,197, as compared with $1,223,529 in 1919. The consolidated income account for the year 1920 compares as follows:

	1920.	1919.
Gross	$8,314,219	$6,203,109
Expenses and taxes	6,018,290	4,003,739
Net	2,295,929	2,199,370
Charges	1,055,732	975,841
Surplus	1,240,197	1,223,529

Northern States Power Co.

The anuual report of the Northern States Power Co. covering operations for the calendar year 1920 gives the following data:

	12 mo. ended Dec. 31— 1920	1919
Gross earnings	$11,798,778.84	$9,875,934.34
Net earnings	4,466,938.23	4,117,312.69
Fixed charges	2,148,470.28	1,999,055.83
Balance	2,318,467.95	2,118,256.86
Pref'd dividends	1,341,374.22	1,176,998.02
Balance available for amortization, depreciation and common dividends	977,093.73	941,258.84

American Power & Light Co.'s Subsidiary.

	1921	1920
January gross	$ 2,295,139	$ 1,771,110
Net earnings	737,258	749,526
12 mo. gross	22,239,121	16,603,066
Net earnings	7,419,042	6,346,258

Carolina Power & Light Co.

	1920	1919
December gross	$ 143,597	$ 119,242
Net after taxes	44,187	34,435
Total income	82,711	70,782
Surplus after charges	64,198	54,801
12 mo. gross	1,598,558	1,249,809
Net after taxes	446,207	398,443
Total income	622,188	558,099
Surplus after charges	412,430	368,203
Balance after preferred dividends	277,068	241,180

New England Co. Power System.

	1921	1920
January gross	$ 433,068	$ 483,238
Net after taxes	149,072	133,160
Surplus after interest charge	73,669	66,843
12 mo. gross	5,906,274	4,384,172
Net after taxes	1,692,119	1,514,461
Surplus after interest charge	870,093	748,134

Dayton Power & Light Co.

	1921	1920.
March gross	$366,321	$318,052
Net earnings	105,030	98,666
Total income	105,791	101,214
Sur. after charges	50,117	51,970
Bal. aft. pfd. divs	32,041	34,468

Utah Power & Light Co.

(Including the Western Colorado Power Co.

	1921.	1920.
February gross	$ 591,074	$ 538,260
Net after taxes	286,591	242,017
Total income	296,924	253,367
Surplus after charges.	152,610	112,957
12 mo. gross	6,861,464	5,781,316
Net after taxes	3,244,329	2,767,577
Total income	3,392,572	2,884,397
Surplus after charges.	1,678,567	1,223,821
Balance after preferred dividends	1,087,067	648,365

Navada-California Electric Corp. and Subsidiaries.

	1921.	1920.
February gross	$ 249,583	$ 235,354
Net after taxes	120,236	111.675
Total income	119,587	111,305
Surplus after charges.	30,053	40,909
12 mo. gross	3,098,613	2,717,914
Net after taxes	1,649,495	1,449,613
Total income	1,640,765	1,444,397
Surplus after charges.	663,376	537,149

Tennessee Power Co.

	1921.	1920.
February gross	$ 197,390	$ 182,300
Net after taxes	77,061	82,771
Surplus after charges.	25,484	29,488
12 mo. gross	2,488,161	2,122,692
Net after taxes	910,596	839,271
Surplus after charges.	276,011	194,520

Dividends.

	Term.	Rate.	Payable.
Cleveland El. Illum., pfd.	Q	1.5%	May 2
Consolidated Gas	Q	$1.75	June 15
Montreal Lt., Ht. & Pr.	Q	1.25%	May 16
J. G. White Mangt. Corp., pfd	Q	$1.75	June 1

WEEKLY COMPARISON OF CLOSING BID PRICES OF SECURITIES OF LEADING ELECTRICAL COMPANIES.

Quotations furnished by F. M. Zeiler & Co., Rookery Bldg., Chicago.

	Div. rate. Per cent.	Bid Apr. 25.	Bid May 2.
Public Utilities—			
Adirondack Electric Power of Glenns Falls, common	6	8	10
Adirondack Electric Power of Glenns Falls, preferred	6	71	71
American Gas & Electric of New York, common	..	101	102
American Gas & Electric of New York, preferred	6	38	39
American Light & Traction of New York, common	..	93	92
American Light & Traction of New York, preferred	6	82	82
American Power & Light of New York, common	4	58	59
American Power & Light of New York, preferred	6	70	70
American Public Utilities of Grand Rapids, common	..	8	7
American Public Utilities of Grand Rapids, preferred	7	18	18
American Telephone & Telegraph of New York	..	108	109
American Water Works & Elec. of New York, common	..	4½	5
American Water Works & Elec. of New York, particip	7	7½	8
American Water Works & Elec. of New York, 1st preferred	..	46½	47
Appalachian Power, common	..	3	3
Appalachian Power, preferred	7	25	27
Cities Service of New York, common	+extra	247	243
Cities Service of New York, preferred	6	66½	67¼
Commonwealth Edison of Chicago	8	108	108
Comm. Power, Railway & Light of Jackson, common	..	9½	10
Comm. Power, Railway & Light of Jackson, preferred	6	30	30
Federal Light & Traction of New York, common	..	7	6½
Federal Light & Traction of New York, preferred	..	41	41
Northern States Power of Chicago, common	..	47	47
Northern States Power of Chicago, preferred	ex.div.7	80	80
Pacific Gas & Electric of San Francisco, common	..	48	49
Public Service of Northern Illinois, Chicago, common	7	77	78
Public Service of Northern Illinois, Chicago, preferred	6	81	82
Standard Gas & Electric of Chicago, common	..	11½	12
Standard Gas & Electric of Chicago, preferred	8	34½	34½
Tennessee Railway, Light & Power of Chattanooga, common	..	¾	¾
Tennessee Railway, Light & Power of Chattanooga, preferred	6	5	6
Western Power of San Francisco, common	..	24	25
Western Union Telegraph of New York	..	92	94
Industrials—			
Electric Storage Battery of Philadelphia, common	4	97	98
General Electric of Schenectady	8	138	139
Westinghouse Electric & Mfg. of Pittsburgh, common	7	49	49